SOLVING BATTERY LOCO ELECTRIC ISSUES ● EXTENDING MILL CAPABILITY

THE MAGAZINE FOR MODEL ENGINEERS

ENGINEERING in Miniature

JANUARY 2021 | £4.50

3000 hours of work

7¼-inch Ten-Wheeler build

HOW J. B. FELL PIONEERED RAILWAYS UP MOUNTAINS

RESTORING THE BOTTOM END ON A 5-INCH GAUGE SIMPLEX LOCO

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THE MAGAZINE FOR MODEL ENGINEERS
ENGINEERING in Miniature

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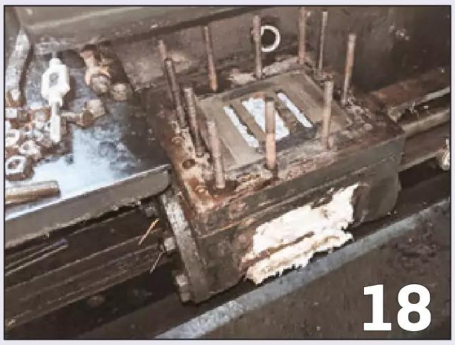

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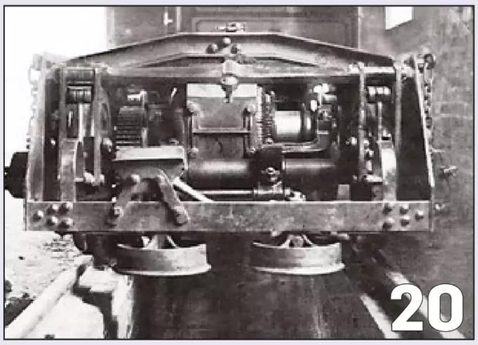

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FRONT COVER

The creation of Jan-Eric Nyström's 71/4-inch ten-wheeler, serialised in our pages, has been a voyage of great discovery, but now after more than 3,000 hours it is looking like a locomotive – still a way to go though!
Photo: Jan-Eric Nyström

EDITORIAL

Getting the young and the old into the workshop...

Welcome to the January EIM as we look forward to a new year that surely has got to be better than the one we are waving a not very fond farewell to? Let's hope so...

Your Ed has been back in the workshop, though sadly not his own, instead creating more piles of swarf alongside tech ed Harry at the Fairbourne Railway making sthe likes of bushes for point linkage and brake pins. My finish is getting better as rusty skills are brought slowly back to life and I'm all the more determined to be back in my workshop ASAP. Luckily crazy pre-Christmas deadlines that see my sending this magazine and sister title *Narrow Gauge World* to press within five days of each other do create a window afterwards to tackle the mess in the garage so here's hoping!

If someone you know is tempted to take up model engineering but worried about getting started, make sure you point them at next month's issue. Our resident young engineer Matthew Kenington, just 15 years of age, starts a new short series aimed firmly at beginners, and those who follow it will have a completed oscillating engine to show off at the end...

Again I make my usual plea for feature material – but it is a pertinent plea. The core of EIM's editorial content is of course focused on encouraging readers to make things, advising on techniques to assist your model engineering, describing projects built and such. But in a typical year we of course also cover the shows, the major rallies, highlighting model engineering activities that we know also interest our readers.

In 2020 there was none of that, with all the major shows and gatherings falling victim to the Covid-19 pandemic, and such is set to continue into at least the early stages of 2021 with the London show already cancelled. All of which means our editorial content has been virtually all workshop-based model engineering. Now while that might please many a reader, the insatiable appetite of our pages has left the features bank looking somewhat low.

So please, if you have produced something interesting in your workshop, be it rail, road, stationary, horological, marine or something other, or even if you have a tale to tell or a technique to highlight that you feel would interest your fellow readers, write it up and help yourself to a slice of our editorial budget! **Andrew Charman – Editor**

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At this time, we would usually be announcing our next Warco Open Day. With the current Covid-19 restrictions it is not possible to hold this popular event. In the meantime, please view our Used Machine list on our website. Our showroom is now closed to the public

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Building a Ten-Wheeler

Jan-Eric's continuing 7¼-inch gauge locomotive build project focuses this month on the essential aspect of watering the iron horse.

BY **JAN-ERIC NYSTRÖM** Part Twelve of a series

With 35 litres of water in the tender, the Ten-Wheeler won't be a thirsty locomotive, providing one can get the water into the boiler! I have two ways of doing this; the dual piston-rod pumps, as well as a steam pump. The piston pumps only function when the loco is running, so the steam pump is very necessary in order to replenish the boiler water while standing still, loading passengers, or when the safety valve is blowing and wasting water.

Photo 146 shows the status of the right-hand cylinder before it was lagged. Our Finnish locos were usually (but not always) built with long piston rods, sticking out through the front cylinder cover. The piston rod sheath protected the rod, but in my model, it also serves another function; it is the 'water cavity' of a pump.

The actual pump body is hidden inside the loco frame, as described in a previous issue – so visually, you won't even know that the rod sheath is a pump! There are of course two of these pumps, one for each cylinder. The other feed pump, steam-operated and disguised as an air compressor, was described with full drawings in the July 2020 issue of EIM.

Figure 38 shows the entire feedwater system for this live-steam locomotive. In the diagram, I've used 'chemical engineering symbols' for the different parts, so that you can follow the paths of the water from the tender into the boiler. It looks complicated, but it's actually very logical.

All the non-return valves are constructed in the classical way, with stainless-steel balls on conical seats. The water is fed to the boiler via the pipes that in the original loco actually were the sand pipes, blowing fine sand from the sand dome onto the rails to increase friction and prevent slipping during starting or running uphill or with a heavy load. My miniature loco does not have that feature, so the otherwise empty sand dome can function as the inlet point for the boiler feedwater. In this way, no extra feed pipes are required, and the loco will look more prototypical.

"The otherwise empty sand dome can function as the inlet point for the boiler feedwater... no extra feed pipes are required..."

The inlet to the boiler is a bit complicated, since the water comes from two pumps, and there also has to be a by-pass pipe, and a bleed pipe with a needle valve for 'priming' (letting the air out), as well. Without a priming outlet, any air left in the system would interfere with the water feed – the piston and steam pumps wouldn't pump any water; they would only cause the air to pulsate back-and-forth in the feed pipes!

Building the inlet

All of this meant that I had to design an inlet with four connections. Photo 147 shows how I solved the problem: a rectangular brass block with four drilled, threaded pieces made of hexagonal brass rod, with internally turned valve seats, which will all be hidden inside the sand dome.

The hex rods connect to the pipes with 'banjo' joints, small and simple, very familiar to most live steamers. Threaded plugs connect the parts and

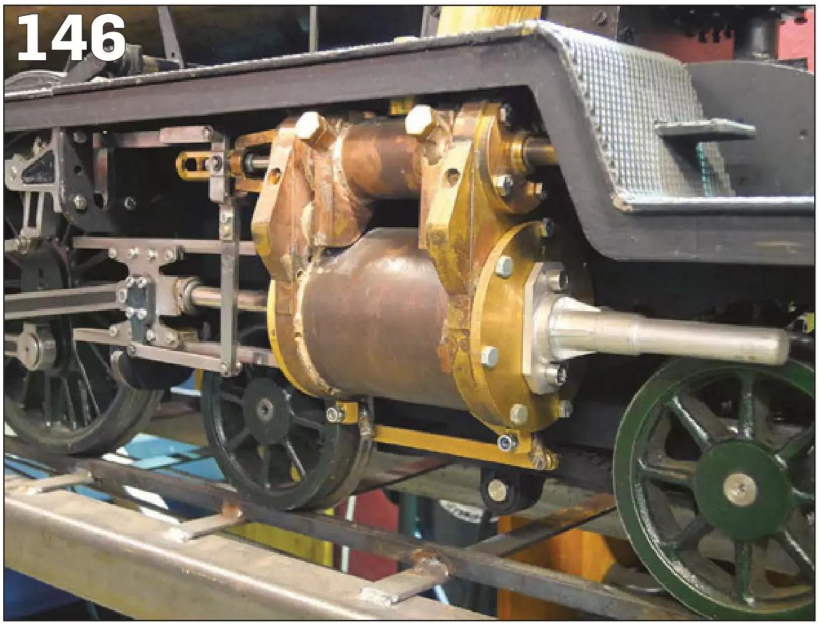


PHOTO 146: The engine's cylinders are fabricated from brass and bronze parts.

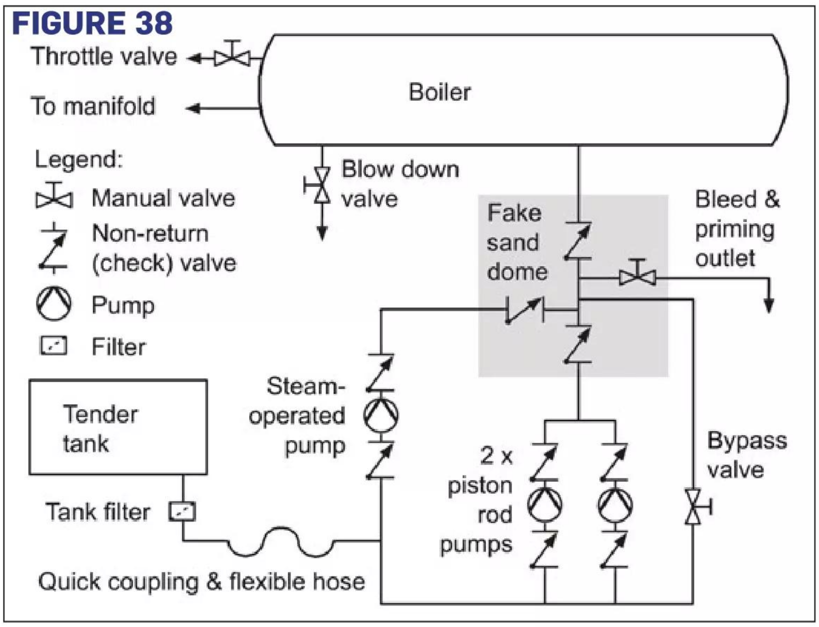
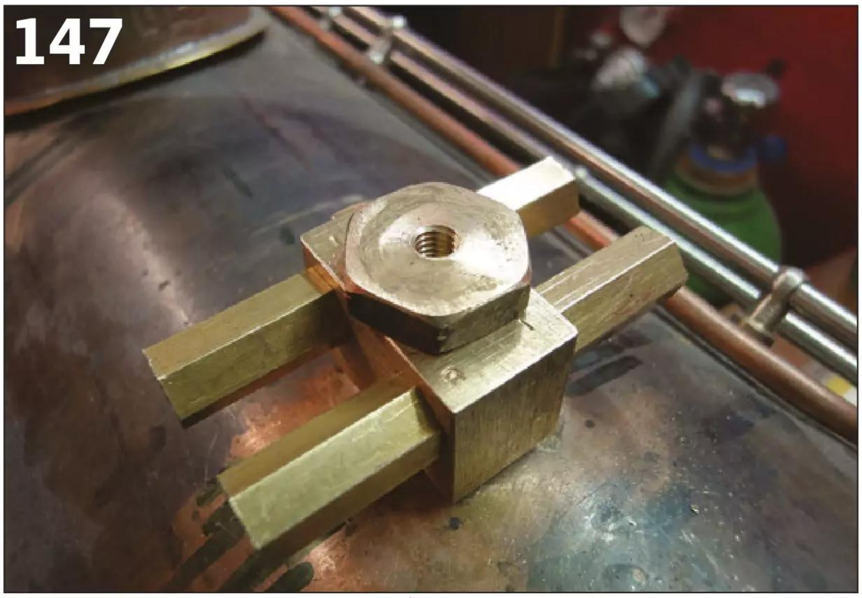


FIGURE 38: Diagram showing how the feedwater system works.

All photos and drawings by the author



seal the system. The dimensions of the parts had to be adjusted so that they fitted inside the dome, and did not protrude too far on the outside, either. The holes in the dome also had to be drilled and subsequently filed to a suitable, slightly oval shape, allowing the banjo rings to exit, but not leaving too large gaps around them.

Photo 148 shows an assembly test at this stage – very necessary, since I usually don't make any drawings either before or during building a model, other than an occasional sketch in order to visualize a more complicated item – and of course the CAD drawings necessary for laser and water-jet cutting!

I usually work from the original full-size factory drawings, modifying where necessary, and 'ad-libbing' for function, size or simplification. This may not be 'accepted practice', but I find it inspiring and challenging. I do get a lot of scrap metal in the waste basket, though...

The dome is made from a piece of 75mm diameter copper-nickel tube, and a plate-brass top, 'spun' to a cup shape on the lathe, is soldered on. The 'skirt' is made of 1mm brass, and also simply soldered to the tube. This is much faster than fabricating the dome from solid, even though it lacks the beautiful compound curve you can get between dome and skirt by hand filing. But I'm more of a functionalist than a perfectionist – as you've probably noticed before.

Note that the dome 'rides high', about 6mm above the boiler – this is intentional, there has to be enough space for the boiler lagging and cladding under the dome! With the hexagonal rods and the banjo rings turned to the correct length, I could assemble the entire system. In Photo 149 you can see it on top of the boiler – in this picture, the front of the engine points downwards. I have

"This may not be 'accepted practice', but I find it inspiring and challenging. I do get a lot of scrap metal in the waste basket, though..."

PHOTO 147: Planning of the valve assembly begins with a few pieces of brass.

PHOTO 148: 'Fake' sand dome encloses water valves.

PHOTO 149: Completed feed-valve assembly.

FIGURE 39: Quick 'X-ray' sketch of the valve assembly and its parts.

silver-soldered 6mm copper tubing to the banjo rings, and bent the tubes according to the sand pipes of the prototype, in order to conform to the boiler shape.

The quick 'X-ray' sketch in Figure 39 shows the construction of the parts – note the two inlets, top left and lower right, each having a ball valve to prevent the water from flowing the wrong way. The pipe to the by-pass valve is at top right, while the simple ▶

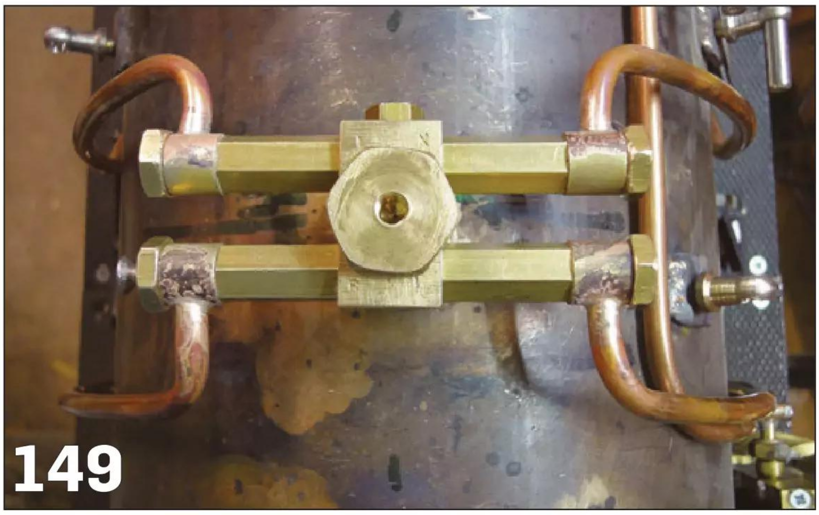
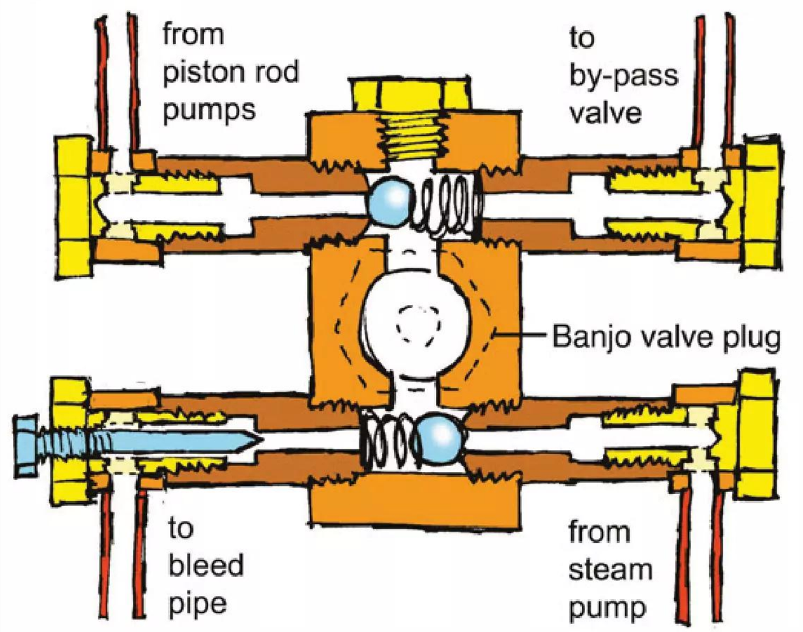


FIGURE 39



'bleed and priming' needle valve is built into the plug at lower left. In fact, the entire rectangular block is functionally equivalent to a banjo union, even though it is criss-crossed with holes and threads for all the other parts.

The block is attached to the boiler with a typical perforated and threaded banjo-joint plug, seen in Photo 150. Note, however, that this plug contains an additional ball valve – this is very necessary, in order to avoid steam from the boiler escaping into the by-pass and bleed lines (you can see this non-return valve symbol in the diagram, too, inside the dome, just before the water's exit to the boiler.)

This ball valve, as well as the two valves in the hexagonal rods, all need stainless steel springs due to their position; this one is 'upside down', so to speak, while the two others are horizontal. Without springs, the balls would not seat properly (the valves in the piston rod pumps need no springs, since they are vertically oriented, proper seating is provided by gravity).

Domed...

In Photo 151, everything is in place, the dome is attached and secured with an acorn nut on a brass rod that is threaded into the banjo plug. This design simulates the sand pipes of the prototype, even though the banjo

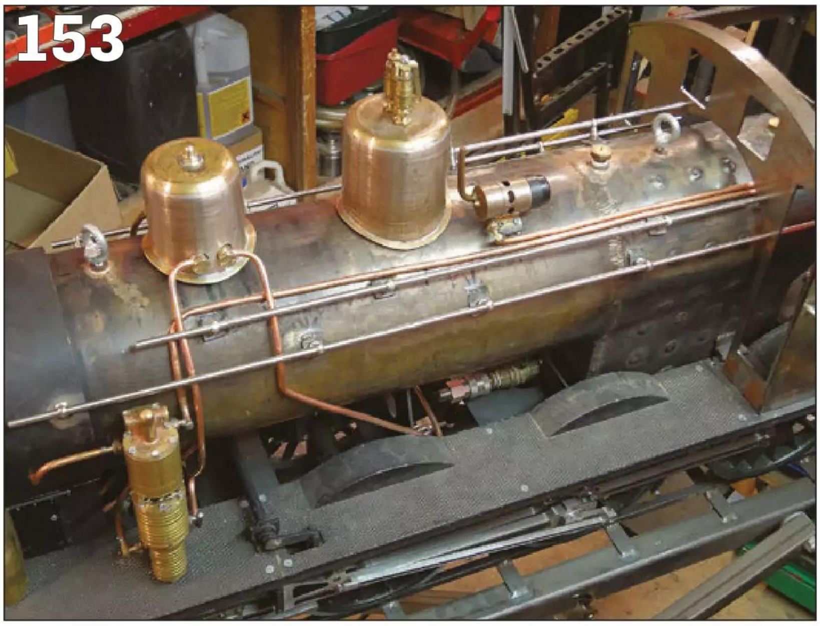


PHOTO 150: The 'banjo-plug' check valve that attaches the valve block to the boiler.

PHOTO 151: Sand dome with fake sand pipes – they carry water!

PHOTO 152: Steam dome in the back sports two safety valves.

PHOTO 153: Piping on the left-hand side of the locomotive.

PHOTO 154: At this point, Jan-Eric had spent almost 3,000 hours working on the Ten-Wheeler build project.

connectors are a bit too large to be in scale.

The Phillips-head stainless screw is the 'needle' of the bleed valve, and can be opened when the loco is being prepared for a steam-up. With this valve open, I can push the cold loco a few feet along the track, and the piston pumps will be properly primed when water exits the bleed pipe. Likewise, when steam has become available, a few strokes of the steam pump will empty its water cylinder and the corresponding pipes of any air, and water will again emerge from the bleed pipe. Then, with no air remaining in the system, I can close the valve.

This valve will also enable me to check the proper functioning of the main check valve (the upside-down one in the banjo plug) – if there is steam coming out of the bleed pipe, I'll know that the main valve is leaking.

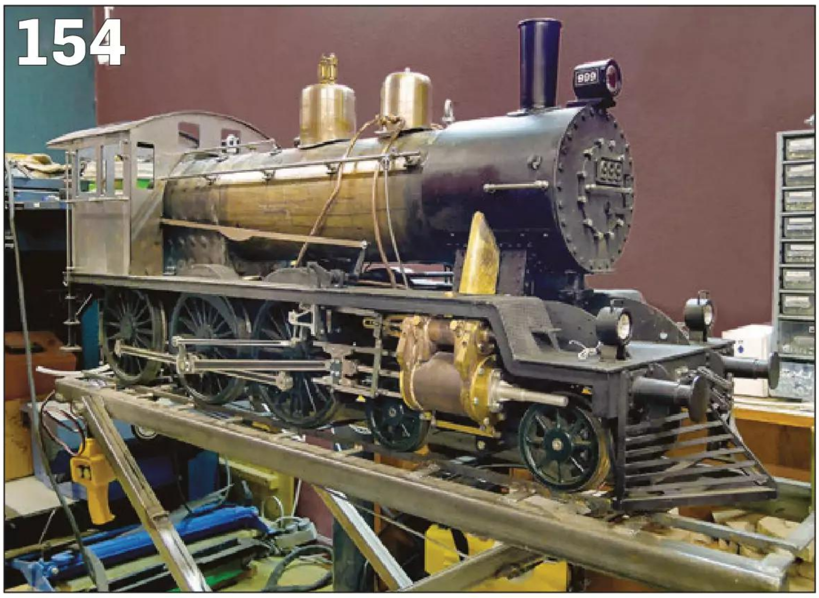
All the piping can be seen in Photo 152, showing the top of the boiler. The steam dome is behind the fake sand dome, with two safety valves prominently attached on top of it. The design of these 'pop' valves was described on page 303 in the March 2016 issue of EIM.

In Photo 153, taken from the loco's left-hand side, I have temporarily attached the turbo-generator, recently described. The by-pass valve is still to be designed and built; it will be installed in the angled 'sand' pipe coming down from the fake sand dome, and will be operated from the cab, via the topmost handrail.

Almost hidden in the frame under the boiler you can see the quick-release connector for the blowdown pipe, which will be removable. Running at the museum, with the public swarming all around, I've had occasional difficulties finding a suitable place to perform blow-downs with my previous locos, which blow the steam and hot water straight to the side, through a pipe emerging from within the frame. On this loco, with a removable pipe of suitable shape (which may even connect to a hose) I will be able to direct the blowdown to wherever I want.

Photo 154 shows the right-hand side of the engine in its state at this stage of the build – as you can see, most of the major mechanical parts are completed and in place. However, I would still need both luck and perseverance, and many, many more hours yet to be spent in the workshop before I could take the loco out on my track for its first run! EIM

"With the public swarming all around, I've had occasional difficulties finding a suitable place to perform blow-downs with my previous locos..."



■ Parts 1 to 11 of this construction series appeared in the February to December 2020 issues of EIM. To download digital back issues or order printed versions go to www.world-of-railways.co.uk/store/back-issues/engineering-in-miniature or order by phone on 01778 392484.

TIPS FOR MODEL ENGINEERS

Setting up a Milling Vice

Harry offers some guidance on a technique it pays not to get wrong...

BY **HARRY BILLMORE**

When I started in the workshop one of the things that it took a surprising amount of time for me to learn was how to set up a vice on a milling machine – it was only once I had my own machine and wasn't borrowing other people's mills that I needed to set up a vice.

There are a couple of ways of doing it, but the easiest and simplest way I have found so far is to first clean the table down thoroughly, and also the base of the vice – it is very irritating to lift your vice onto the table only for a bit of swarf to land right on the bed!

Once the vice is on the bed, put it as far to the back as the holding-down lugs will allow. This is so you have as much movement forwards and backwards available as possible with the vice jaws a long way open. It also means the vice is supported as much as possible.

Eyes on the prize

Put one holding-down T-nut and stud in place and lightly tighten it down, this will act as a pivot to align the jaws with the bed of the mill. Once this is done, eyeball the vice as close as you can to be in line with the bed ways, this will then reduce the amount of fine adjustment you will need to carry out later.

Now mount a dial indicator into a chuck and position it at the end of the vice that has been fixed down, with at least a turn of the dial available to read from, this will then show you if the other end of the vice needs to come forwards or go backwards.

Then run the table of the mill along until the dial reaches the other end of the vice. What is shown on the dial is the amount you will need to move that end of the vice by – I prefer to do this using a hide hammer to gently tap the handle end of the vice, then repeating the procedure until the dial doesn't move.

Finally fit the second holding down T-nut and stud, tighten everything firmly down and then double check using the indicator that it is square and true once again.

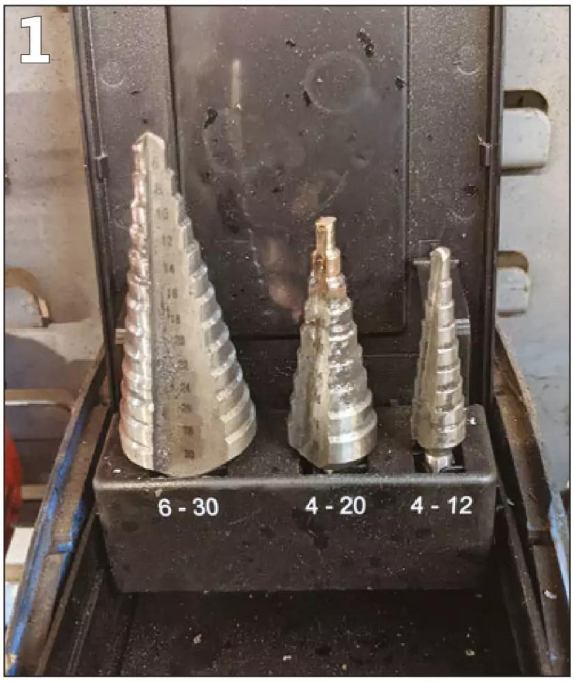
RIGHT: Dial indicator set to 0 at the end of the jaw, with a turn of pre load to give an accurate reading as you move the indicator down the jaws.

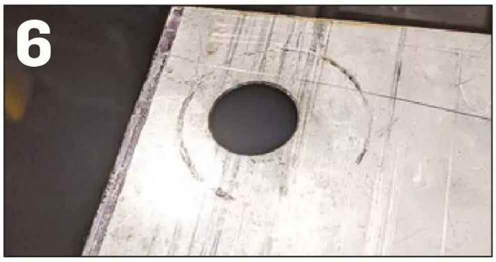
■ Do you have a tip for your fellow model engineers? Send it in to the editorial address on page 3

Taking the first step...

Harry offers his views in praise of the humble step drill – even cheap ones from Aldi...

BY **HARRY BILLMORE**





There are many ways of making holes in thin sheet material, but my favoured method is to use a step drill. These ingenious tools have a pair of cutting faces running along their length and as the name suggests, a series of steps of increasing size running concentrically around the shank.

This format results in the cutting edge being nowhere near as aggressive as on a twist drill, and due to the cutting faces running parallel to the shank they do not wind the material up them as they break through. In the example pictured here I am drilling an 18mm diameter hole through some 0.6mm thick stainless steel – if you have never used stainless, it is a horrible material to work with, it snatches and grabs as well as being extremely hard.

In use step drills are very similar to normal drills, running them slower as the diameter increases and using cutting fluid will help keep the edge sharp for longer.

As you can see in the photos, with stainless steel especially a small amount of material is pushed through the hole and will form burrs, but, again thanks to the stepped design of the drill, simply turning the workpiece over and using the next-sized step to deburr works very well. You are left with a very clean hole, quickly and with a minimum of fuss.

Value for money

As with most tools you can spend what you like on step drills. If you are planning on using them a lot, paying a little more means the edge lasts longer, but I have had a decent amount of work from a set I bought from an Aldi supermarket for £2.99 – you don't need to break the bank!

Step drills are also very useful for drilling larger holes in thicker material – the gaps between the steps being 3mm, if you drill from both sides you can get a very nice hole in 6mm plate up to 30mm in diameter using my set, and this is by far the easiest way of making that size a hole.

They are also available without distinctive steps as a cone drill. This will have the advantage of being able to produce any size hole you might require – however when used in thicker material the resultant hole will have tapered edges. EIM

PHOTO 1: Typical set of step drills covering a range of hole sizes.

PHOTO 2: One of the cutting edges of the drill, with the sizes handily marked on it.

PHOTO 3: Set up and ready to drill the hole in similar manner to a twist drill.

PHOTO 4: Close-up of the resultant hole.

PHOTO 5: The reverse side of a hole made by a step drill will have significant burrs...

PHOTO 6: ...but these are easily removed by using the next drill size up as a deburring tool.

Photos by the author

Current Affairs

Peter continues his new series on battery-electric loco wiring issues, this month describing how faults can be diagnosed and looking at further potential problems.

BY **PETER KENINGTON** Part three of a short series

In the first two parts of this series (EIM Nov, Dec 2019), we discussed how problems in a battery-electric locomotive's wiring could result in the premature failure of one of the motors or the controller. In this part, we look at how problems can be diagnosed before they result in a failure, and also at a separate wiring problem, one of design/construction, which can result in the failure of the controller.

Diagnosis and Cure

Whilst parts 1 and 2 of this series discussed the merits of series-wiring of electric motors, most battery-electric locos are currently parallel-wired and so it is worth delving deeper into how we can diagnose and fix problems with this configuration. There are two main reasons why parallel-connected motors may 'burn out' more easily than series-connected motors:

1) An imbalance in the electrical characteristics of the motors can cause one motor to undertake more of the work than its partner (or partners). In extreme cases, this motor may take the majority of the load, leading it to burn out relatively quickly.

Such an imbalance may occur due to manufacturing tolerances, but is much more likely to occur when a motor is replaced with one of 'equivalent' rating. The new motor may well be sufficiently different, notably in its winding resistance, that it takes either a disproportionately high or low share of the load.

2) A poor or corroded contact on one motor (which introduces an additional resistance to that motor's circuit, as discussed earlier in this series) will result in the other motor taking a significantly higher share of the load and hence overload that motor, causing it to fail prematurely.

How can we tell if either of these is occurring in our loco? The simplest method is by using a clamp-ammeter (Photo 5). A clamp ammeter is a measuring instrument which can measure current flowing in a wire without the need to insert it into the circuit under test.

Traditional clamp ammeters would only work on AC circuits, however the invention of Hall-effect sensors means that modern meters will measure both AC and (crucially for our purposes) DC currents. They will also, typically, measure the high currents of interest to us with ease – not something which is so straightforward with a shunt-based ammeter (see Jan-Eric Nyström's experiences with a cheap Chinese ammeter in his battery-electric loco, EIM October 2019).

The clamp ammeter shown in Photo 5 also doubles as a conventional multimeter, with probe terminals and probes provided and so is quite a handy bit of kit. These meters are not overly expensive, with reasonable examples costing around £30 (a fraction of the cost of a new motor!). Note that it is important to check that it will measure both AC and DC currents – cheaper models are available which will only measure AC, so beware.

In the photo the clamp ammeter is in use, measuring the DC current flow from a 12V battery to an inverter (for illustrative purposes). The important thing to note is that only one of the 12V connecting wires is enclosed within the 'clamp'; if both wires are enclosed, the meter will appear to show that no current is flowing. The same is true when measuring AC currents, so don't try testing out your shiny new meter by clamping it around the mains cable of your kettle – it won't work (although it won't be dangerous either).

In the context of a locomotive, the ammeter is easy to use – the main difficulty lies in seeing the reading whilst driving the loco. It is probably best to get a friend to take the readings whilst you concentrate on the driving and, ideally, the measurement should be performed with a decent passenger load (volunteers shouldn't be hard to find!). Figure 10 shows the location at which to take a measurement to assess the current drawn by Motor #1 and Figure 11 shows the equivalent location for Motor #2.

Be careful to ensure that you are measuring the correct point in the circuit. Tracing the wiring from the motor end is the best strategy, as this is the least likely to lead to mistakes. Ideally, it is best to measure as close to the motor as practicable, simply to ensure that the correct wire is 'clamped'. This must be balanced against the ease with which a reading can be taken, of course.

If the two motors are sharing the load well, then both current readings should be near-equal. If one is showing a rather higher reading than the other, then the fault is likely to be associated with the motor showing the lower current reading – contact resistance or excess resistance between the brushes and the commutator on the motor (for example due to dirt or corrosion on the commutator or excessively-worn brushes) are probably the cause.

If one motor has failed altogether, ▶

PHOTO 5: Using a clamp ammeter to measure DC current.

All photos and diagrams by the author

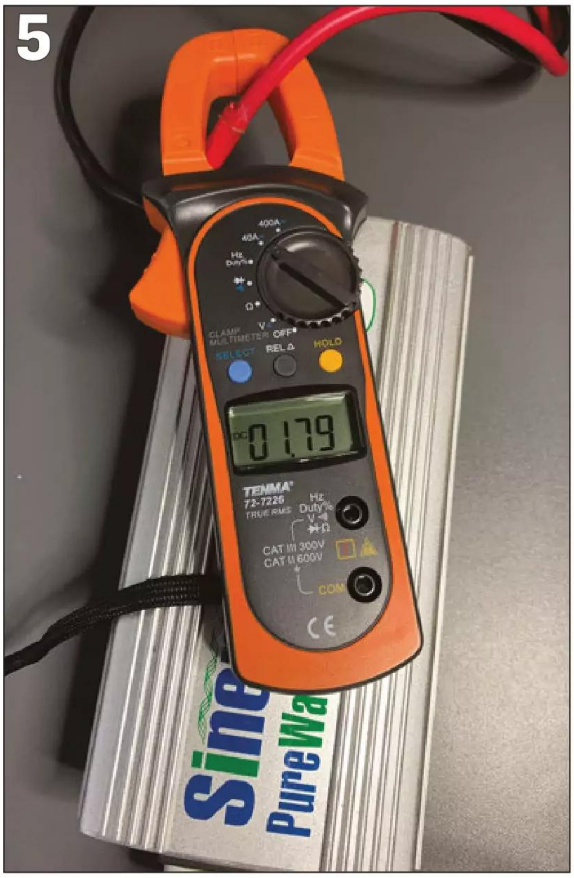
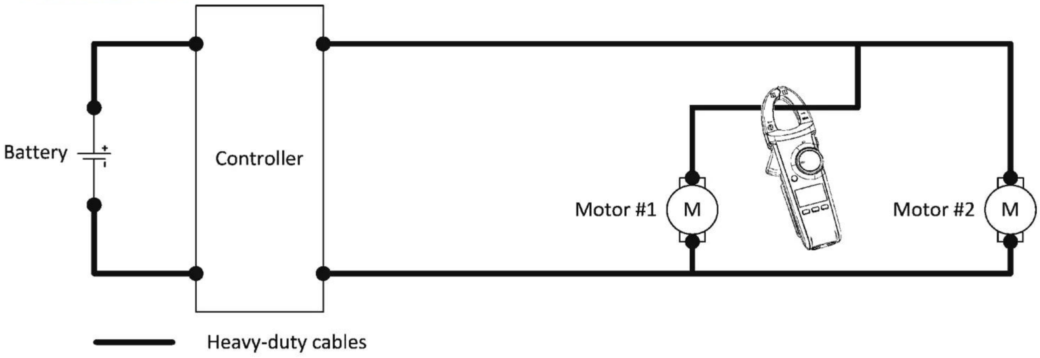


FIGURE 10



consider replacing both motors at the same time, in particular if you need to purchase an 'equivalent' to the failed motor, perhaps as the original type is no longer made. At the very least, having replaced the motor with an 'equivalent', re-check the currents being drawn by each motor on the loco, to ensure that they are near-identical. If not, the other 'old' motor should be replaced with an identical example of the 'new' one.

Note that even if you are using separate controllers for each motor (as in Jan-Eric's design described in EIM through 2019), it is worth performing the above clamp-ammeter tests to confirm that both motors are sharing the load correctly. It is still possible for corroded terminals on one motor to cause a partial loss of power to that motor or for a mechanical issue (such as increased bearing friction) to cause one motor to work harder than its sibling (if they are powering separate bogies, for example).

Tarnished Reputation

Having diagnosed that a particular motor or, more likely, its connections, is to blame, it is time to take a close look at all connections in that part of the circuit (not just those directly to the motor, but any 'chocolate block' connections or other electrical joints in that part of the loco).

In short, all connections should be bright and clean, with no obvious dirt or corrosion. A thin layer of copper oxide is, at best, a semiconductor and so, for our purposes, can easily introduce the kinds of contact resistance discussed above (and very much higher levels). Adopt a 'zero tolerance' approach here, as even small amounts of corrosion can have a marked impact.

"The outward wire on one side of the chassis and the return wire on the other, would be a very poor choice..."

FIGURE 10: Using a clamp ammeter to measure the current in the first motor.

FIGURE 11: Using a clamp ammeter to measure the current in the second motor.

PHOTO 6: Use of a lathe to produce a 'twisted-pair'.

PHOTO 7: Close-up of lathe-chuck holding wires.

PHOTO 8: Close-up of Jacobs chuck holding wires.

Fine-grade emery paper should suffice for most forms of corrosion, although it may be necessary to resort to a coarser grit or even (with care) a small file, if severe corrosion is encountered. In particular the 'female' part of a spade connector is often most easily cleaned by means of a thin needle file inserted where the male spade would normally go.

'Switch cleaner' (the best-known brand being Servisol) can help (particularly in inaccessible locations) but is no substitute for mechanical cleaning where this is practicable. In particular, the cleaner needs to penetrate to the problem (in other words the corrosion) and if this is underneath a clamping screw or inside a crimped connection, then it can't do its job. If in doubt, chop off the old terminal and crimp on a new one, onto freshly-stripped, clean, bright, copper.

Pay attention, also, to the tightness of connections. Screw terminals should be tight – check these regularly, as they will loosen over time, as the conductors within the cable 'settle' and the cable flexes with the motion of the loco.

Spade connections should likewise be tight – it should be a bit of a struggle to push the terminal onto the spade. In the same manner as with screw-connections, the crimp connection to a spade may have 'settled' over time and need to be re-crimped (primarily, if it wasn't properly crimped when made). In short, don't assume, check!

Inductance kills

The above discussion has probably given the impression that what flows down the wires from the controller to the motor(s) is a DC current. Since most controllers used in model locomotives (and, indeed, golf buggies, electric wheelchairs and such) are based on pulse-width modulation (PWM), the current transferred is actually a high-frequency AC waveform which is, in effect, converted to DC by the motor itself.

A detailed explanation of PWM is a little involved for a general model engineering article, but there are plenty of explanations of the operation of PWM systems online, so a quick Google of the term should satisfy the curious. The important point for our purposes is that we are conducting a high-frequency AC waveform along our (fairly thick) copper wires.

All wires, in addition to their intrinsic resistance discussed earlier in this article, will possess a property called inductance – the longer the wire, the greater the inductance (all other things being equal, notably the shapes into which the wire is bent – more on this in a minute). Again, without going into too much electrical detail, inductance can be thought of, in this context, as an additional resistance, to AC signals.

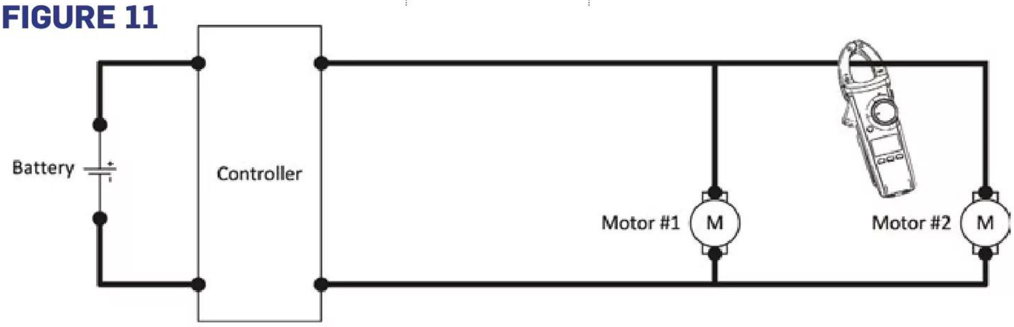
In other words, the total 'resistance' seen by the current emanating from the controller is a combination of the resistivity of the copper making up the conductor in the wire and the added 'resistance' to the flow of the AC PWM waveform along the wire. The combination of the two is known as the impedance of the circuit (or wire, in this case), as it impedes the flow of electricity along the wire.

The routing of the wires is also an important factor – in general, if there is a large 'loop' in the wiring, then this will increase the inductance of that wiring. The way that the circuit diagrams are drawn in this article (and, indeed, in general for circuit diagrams) may create the impression that a loop is normal and/or the right thing to do.

Each circuit discussed above shows the 'outward' (upper) connection being some distance from the 'return' (lower) connection and the whole outward-return circuit appears as a loop. It should be emphasised that this is a convenience in the drawing of circuit diagrams – it aids clarity in following the paths of the wires – it is not a suggestion of the physical layout of the wires!

Indeed, such a layout, for example having the outward wire on one side of the chassis and the return wire on the other, would be a very poor choice, as it would introduce a large inductive loop. This is true of both the battery

FIGURE 11



connections to the controller and the connections running from the controller to the motor(s).

It would be very easy, at this point, to disappear down the rabbit-hole of discussing transmission-line theory and the design of such for the model engineer, however (fortunately) it is not necessary to understand this in order to benefit from its implications.

As a quick insight, have you ever wondered why the signals from your TV aerial or satellite dish need to come down a piece of coaxial cable? This is, in part, due to the screening properties of the cable, preventing interference from degrading the picture, but mostly because a simple piece of wire (as used in the house ring-main, for example) would hugely impede (i.e. resist) the transfer of the (very) high frequency signals received by your TV or satellite aerial, to your TV set.

The coaxial cable forms a low-loss transmission line (by virtue of its design) and keeps the transmission losses to a minimum (although simple resistive losses still exist, along with other losses in the materials making up the cable).

"But surely, we're not talking about watching Eastenders in the cab of our loco?", I hear you say. We aren't, however we do need to transfer some high-ish frequency PWM signals to our motors and do so along some reasonable lengths of cable. The answer is to do what telephone engineers (and, more recently, Ethernet cable designers) have done for decades: twist the wires together to form a 'twisted pair'.

This is a simple form of transmission line and, despite its simplicity, surprisingly effective (gigabit signals find their way to the laptop on which I'm writing this article by just such a means). Twisting the wires together means that they act (electromagnetically) very differently to a single 'there-and-back' wire arrangement, effectively eliminating the issue of inductance in the individual wires.

Let's Twist Again

The simplest way to twist wires effectively, in my experience, is to clamp one end of the pair of wires in a vice and the other end in the chuck of a hand-drill (for thin wires). For thicker cables, a lathe chuck **NOT operating under power** can be substituted for the drill with the wires clamped in a tailstock-mounted drill chuck or with a G-clamp (or similar) to the tailstock itself (for very thick wires which won't fit into a tailstock chuck).

The former option is shown in **Photo 6**, with a close-up of the wires held in the lathe chuck being shown in **Photo 7** and a similar photo for the tailstock-mounted Jacobs' chuck in **Photo 8**. Note that the wires shown in these photos were chosen purely to illustrate the technique and are too thin for use in the high-current circuits of a loco.

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Turning the hand drill or manually rotating the lathe chuck should produce a nice tight-ish (don't go too mad here), evenly-twisted, pair of cables. **Photo 9** shows the resulting cable – this cable is relatively loosely-twisted and tighter twists can easily be obtained by this method. The untwisted portion was simply inserted into the bore of the headstock and could have been twisted by moving it out once the original twisting operation was complete (and clamping the already-twisted section to the tailstock with a G-clamp). In this way, long lengths of twisted-pair cable may be created.

One thing to be aware of, when using this technique, is that the tailstock chuck will be gradually pulled out of the tailstock. Depending upon how tight a fit the morse-taper is in your tailstock, you may have to restrain the tailstock chuck whilst turning the lathe chuck. If you do this, then the tightness of the twists can be regulated by the tightness of the tailstock clamp, which clamps the tailstock to the bed-way (although 'unclamped', relying upon the weight and friction of the tailstock, is typically adequate for most cables).

The bed-way clamp method works especially well if the wires are clamped to the tailstock with a G-clamp (or similar), rather than being clamped in a tailstock-mounted chuck, and is recommended for thicker wires.

So, why go to all this trouble (other than the fact that the resulting cable looks a bit neater and is easier to deal with when wiring the loco)? Long (individual) wires, or wires forming loops, can have a (relatively) large ▶

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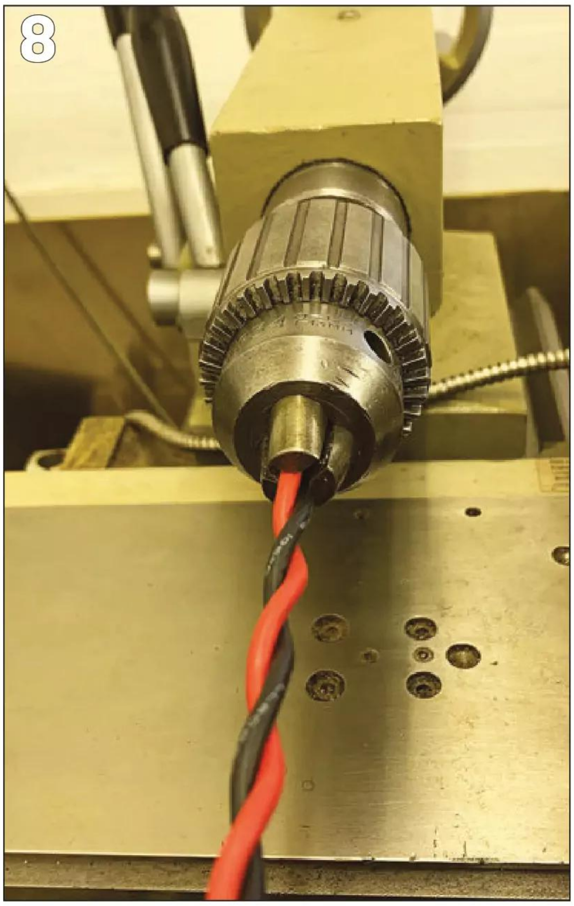

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inductance and can put added strain on the PWM controller, causing the main capacitor within it to fail. As discussed above, these wires are not conducting DC but a high frequency AC (typically in the region of 20kHz) and hence the inductance of the wires becomes as important as their resistance, particularly in large locos with long cable runs. It may not be important in a 5-inch gauge 0-4-0 with the controller a few inches from the motor, however a 7¼-inch gauge Class 37 with the controller mounted at the back and a powered bogie at the front, could be a different matter.

There is also an argument that says: "why not?" – it is not much additional work, makes the routing of the loco wiring simpler (only one cable to route and not two separate wires) and (potentially) extends the life of the controller. You know it makes sense…

In regards to the battery wiring, the physical distance from one end of a pair of series-connected batteries (say, the positive terminal of battery 1) to the other (say, the negative terminal of battery 2) may make the formation of a twisted-pair impractical, since one connection will be far longer than the other. In this case, good practice is to run the cables parallel to each other, where they have a joint-path (for example from the nearest battery terminal, to the controller), thereby eliminating a loop. The use of cable ties, or similar, to ensure this is maintained, is recommended.

It is also worth mentioning ammeters, at this point. Conventional moving-coil ammeters rely upon a low-resistance shunt across their terminals in order to 'drop' a small voltage, which the moving-coil meter then measures. The shunt in these ammeters can (depending upon design) possess an appreciable inductance and hence they should be used with caution; they may (inadvertently) lead to the problem they were probably installed to prevent – such as the failure of the controller!

A better solution would be to construct (or source) something based upon a Hall-effect current sensor – these are available as integrated measurement devices (for example the ACS770xCB family of devices from Allegro Microsystems – which has both 50A and 100A variants available) and could be combined with either an analogue or a digital meter – some simple additional circuitry would be required to enable the meter deflection, from zero to full-scale, to correspond to the current, for example from 0 – 50A). If I get a chance one day, I might try and come up with a complete design…

A list of dos and don'ts...

Just in case you got lost somewhere between 'parallel' and 'series' in the earlier parts of this series or you gave up at 'PWM' in this part, what follows is a summary of the conclusions and recommendations for the wiring of electric locos:

1) Use adequate wiring from the batteries to the controller and from the controller to the motors (and, indeed, between the two batteries, if two are used in series) – if in doubt, make it thicker!

2) Use a 'twisted pair' (discussed above) cable for the wiring from the controller to the motors, if the distance from the controller to either of the motors is long. What constitutes 'long', in this context, depends upon the power of the motors, the rating of the controller and potentially also, the routing of the wiring (specifically any iron or steel work it is close to).

Again, if in doubt, do it anyway – it's simple and quick to do and there's no real downside (other than a small temperature de-rating, but you'll be using 'adequate' cable thicknesses, so this won't be a concern).

Note that this should be carried out for the battery cables as well, for the same reasons (reduced inductance), if possible. If not, run the outward and return cables adjacent to each other (where both are present) and not in an 'outward-and-return' loop.

3) Think carefully before including a conventional (shunt-based) ammeter between the controller and the motor(s) – a solution employing a Hall-effect sensor will be a much better option.

4) Clean all terminals/connections regularly, for example as a part of the post-winter/pre-running season maintenance routine. You wouldn't think of skimping on oiling/greasing your loco; contact cleaning should be viewed in a similar way.

5) Check that your motors are sharing the load equally (just as you do with the household chores, with your partner…). If not, investigate – your (or your club's) bank balance will thank you for it.

6) If you replace a motor, don't assume that it is identical to its (existing) partner, just because the specs look similar – perform the clamp-ammeter tests described above to ensure equal load-sharing.

7) Even if you replace a damaged or worn-out motor with an identical model, that has been sourced from the same manufacturer and supplier, check the load-sharing of both motors – it may be that the old motor has corroded terminals and that was why its sibling failed (see part 2 for a detailed explanation as to why this happens).

8) If the fuse blows (you do have a fuse, don't you…?) don't just replace it and carry on. It's probably trying to tell you something. Investigate why, investing in a clamp ammeter if necessary to do so.

9) Consider employing a series-wired motor configuration if your motors are suitable (or if designing from scratch).

"Even well-designed locos will age and with age can come corrosion..."

To Complete the Story

I said I would return to the 'supposedly' wording used at the start of part 1 of this feature, in relation to the travails of an electric 0-6-0 loco of my acquaintance… If you missed it, a quick precis is as follows.

I was passenger hauling using a (supposedly) commercially-built diesel-outline electric loco belonging to a fellow club member. The loco was a powerful 0-6-0 design employing three electric motors and would usually pull nine adults very easily, with the passenger limitation being set by the configuration of the line and its turntables and not the power of the loco.

On this particular day, however, it was struggling and was consequently withdrawn from service. Given that it was an electric loco and that I am an electronics engineer, plus the fact that my father was also present and he is a

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PHOTO 9: The resulting twisted-pair cable, this one relatively loosely twisted.

retired electrical engineer, we felt well qualified to take a look. The sight that greeted us was nothing short of horrifying – the wiring was all over the place, one of the spade terminals on the controller unit was blackened and had clearly tried to de-solder itself from the printed circuit board on which it was mounted and the board itself was black on the underside, close to this terminal.

Given the state of the wiring and the problems experienced in running it, the owner contacted the manufacturer of the loco to complain – I am deliberately leaving out names here, to spare a few blushes. The manufacturer of the loco could find no record of having sold such a loco to its owner.

To cut a long story short, it turned out that one of the employees of the company had a side-business in taking components from the manufacturer, making (clearly poorer quality) versions of the loco and selling them on to the company's customers. So far as the customer was concerned, they were buying a legitimate product from the manufacturer (at the manufacturer's list price). Needless to say, the said employee found himself in want of employment as a result.

The moral of this story is that even 'professionally' designed and built locomotives, or those that have been built by 'qualified' personnel, are not automatically exempt from suffering from the problems discussed in this series. Even well-designed locos will age and with age can come corrosion, especially if the loco is stored in a damp/unheated environment (garage/engine shed/tunnel).

Annual maintenance/checking of the electrical parts of a battery-electric loco is every bit as important as oiling, greasing and so on are for the mechanical parts.

In particular, a check under load with a clamp ammeter (as described above) should highlight issues before they lead to motor (or controller) failure. What else were you going to do during the 'inevitable' second-wave winter lockdown?

Next time...

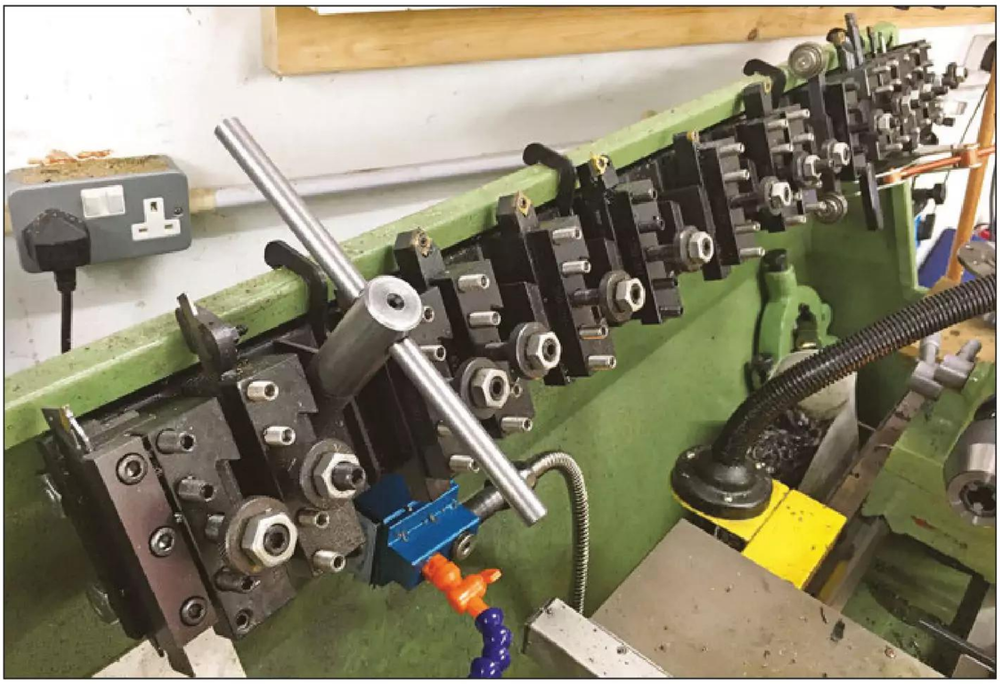
Hopefully you are now confident with the wiring aspects of battery-electric locos. In part 4 of this series, we will consider the other half of the partnership, namely the battery. This is an area in which there is a lot of 'received wisdom', some strong opinions and a lot of hearsay.

Part 4 aims to bring some scientific rigour to this topic, allowing you to extract the longest possible service life from your expensive investment in 19th century electro-chemical technology. EIM

Printing out a tool rack

Nick demonstrates his own clever use of modern technology...

BY **NICK WEBB**



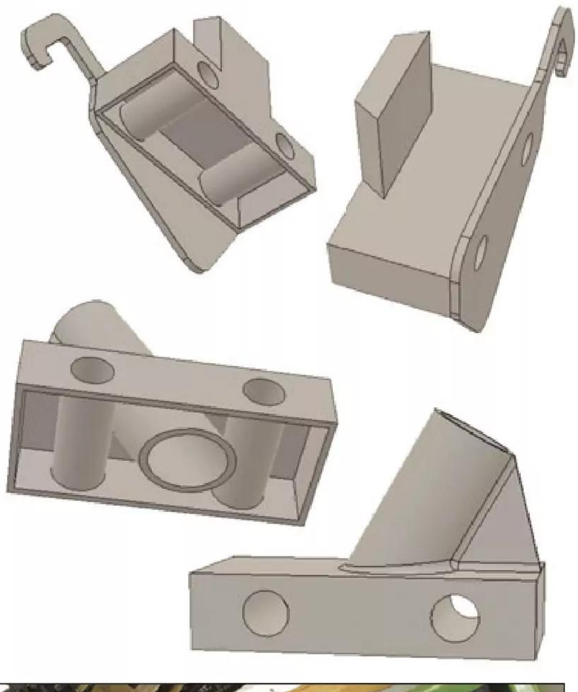
With recent issues featuring the workshop tool-holder racks created by readers, inspired by the 3D-printed versions to keep lathe tool holders tidy described by Peter and Matthew Kenington in the July 2020 issue, I thought I'd show you mine.

The unit is designed to hang on the back of my Warco lathe, and consists of two basic parts:

1) blocks to take the toolholders
2) hangers to attach to the splashback

Both sections are 3D printed, and held together on two lengths of M12 studding, nutted at each end. The main blocks can be threaded on either way round, allowing for both laterally and longitudinally-mounted cutting tools. After producing the ones shown in the pictures I later created a third unit to take the lathe's chuck key.

Hopefully the photos and CAD drawings here are self-explanatory.

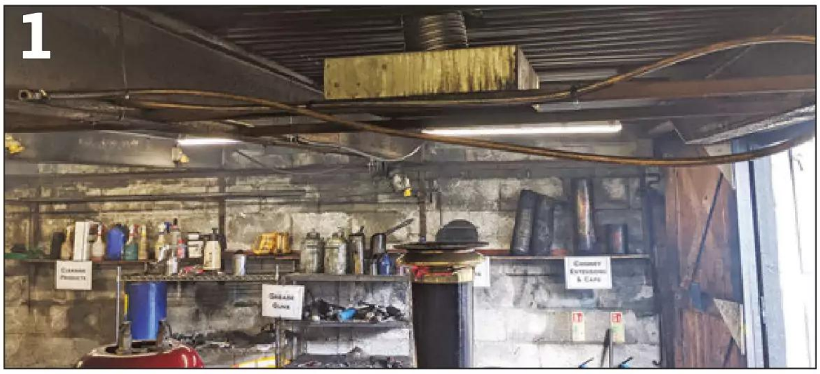


■ Have you come up with a workshop enhancement that your fellow readers would find of interest? Then why not take a couple of pictures, write it up and send it in to the address on page 3?

Behind the Shed Door

Our Technical Editor's day job as resident engineer on the Fairbourne Railway produces another highly varied month meeting the challenges of 6-inch scale miniature engineering...

BY **HARRY BILLMORE**



October in the Fairbourne Railway works began with my making some significant changes to the workshop itself by modifying the air system. I moved the position of our small blasting cabinet away from the end of the workshop where all the machine tools are and into the running-shed end of the building, so as to reduce the amount of abrasive dust that was being showered onto the machine tools during operations involving the use of compressed-air.

To do this I had to re-route an air supply from one side of the running shed to the other, and while doing this I took the opportunity to reduce the trip hazards in the running shed while a loco is being lit up by removing the air lines snaking around the floor. Now there are dedicated air lines hanging down next to each smoke hood in the roof.

Once this little bit of tidying up and improvement had been completed I then settled down to investigate a knock that was being felt on our Welsh Highland Hunslet style 2-6-4T 'Russell'. I soon traced the issue to the leading end of the coupling rods on both sides – both the knuckle joint and the bush onto the crankpin were worn enough for an appreciable amount of movement to be noticeable.

Since none of the other bushes showed the same signs of being worn, I decided to remove one of the rods to make a more detailed inspection. The wear could have been caused by any number of things; blocked lubrication feeds (this is especially a problem on a beach railway where sand gets everywhere) or perhaps too tight machining tolerances when the rods were fitted (potentially exacerbated by the engine running on Vesconite bushes, a type of plastic used in mine conveyor belt bearings). The quartering of the leading wheelset cranks could be off compared to the others on the loco, the crankpin could be excessively worn, the rods could be a different length compared to the horn guide centres, or it could be a combination of all of the above!

Unfortunately on this loco to remove the leading coupling rod you need to first take off the lower crosshead guide bar, which means it is not a really quick job just to put back together. So I waited until a Monday morning on a week when we were not running steam (our diesel on demand service ran throughout October during the week leading up to the Welsh lockdown).

I stripped the loco down and on removing the coupling rod, I then discovered another issue with it. At some point in its life, the position of the grease nipple had been moved to allow easier access for the crews, and the old hole had then been welded up and partially machined back. Unfortunately, probably due to the excessive clearances on the bush causing more hammer stress on the rod eye, the weld has started to crack and this will eventually propagate through the original steel of the rod.

PHOTO 1: First job of month; air lines tucked away in roof – more health & safety friendly...

PHOTO 2: 'Yeo' is lit up using the new air lines

PHOTO 3: Not pretty – cracked weld on eye of 'Russell's coupling rod.

PHOTO 4: Weld repair seen from outside.

All photos by the author unless stated

With this noted, I continued with my investigations into the excessive play, measuring the crank pin and examining it for wear, and measuring the centre positions for the crank pin to the knuckle joint pin on the centre rod. Unfortunately without dropping the wheelsets out there is no accurate way of comparing the quartering, but comparing the measurements I had taken, I discovered the rod was too long by a shade over 1.5mm compared to the crank pin to knuckle joint position.

Decisions, decisions

This left me with a decision to make. I could either repair the existing rod, machine a new bush, put the rod back on and hope it made it through another season. I could make a new rod to the dimensions I had measured up or I could wait until I had the time to lift the loco, measure everything properly, then machine new rods after all the measurements have been taken.

Having decided on the latter

approach and double checked with Murray the FR general manager, I then reassembled Russell and allocated it to reserve engine status for the few steam running days we had left, with an inspection regime put in place to ensure that if the loco had to be used and the crack did start to propagate, then the loco would be withdrawn. My intention is to complete the 10-year overhaul of our Darjeeling loco 'Sherpa' before bringing Russell out of traffic. This is to ensure that at the start of the next season we have a reserve steam loco in case our lead engine, Lynton & Barnstaple 2-6-2T 'Yeo' has any issues.

Once Russell was back in the running shed, for something different myself and one of the volunteers fitted new floor supports and bracing into carriage 17, this vehicle already having had its woodwork repaired and exterior painted by another of our regular volunteers, Peter.

One of the challenges of the Fairbourne being a seaside railway is that rust is a perennial problem with the floor supports of carriages a regular victim. Hopefully the pictures on these pages speak for themselves, rectification is a nice simple job with bits of angle iron supporting the outside edges and a strip across the point in line with the middle of the door to help where passengers put their feet as they step in.

Auto engineering

Another interesting job was investigating a leak on the new engine that had been put into 'Tony', our big Bo-Bo diesel. The engine in question is a unit from a 300tdi Land Rover Discovery SUV. Its top end had been rebuilt already, but when the engine was started and ran for a length of time, an oil leak was discovered coming from the timing cover.

I suspected a crankshaft seal, so started the process of stripping the timing cover off. To do this you first need to remove the auxiliary drive pulley from the end of the crankshaft, this entailed making a spanner to hold the pulley while undoing the bolt that holds it on, thankfully a quick machining job on the lathe and drill. My suspicions were confirmed and a new seal ordered and fitted, which has cured the leak. The next major task on this loco is to sort the braking system out, which will gradually get done as volunteer labour is available.

I also managed to finish the fitting of a set of dampers to our smaller diesel 'Gwril', which has much improved the loco's tendency to bounce along like a kangaroo. I took the opportunity to repaint the axlebox covers in a nice bright yellow.

With the news from Wales First Minister Mark Drakeford that the country was going into a 'circuit breaker' lockdown, and so our running season was effectively over, Russell was drained and winterised. While the news was not great for the railway's income, it did mean I could get a head start on the winter maintenance, and first on the list was to sort out Yeo's valve timing and fix A steam leak coming from between the bottom of the steam chest and the top of the cylinders.

Making a good close inspection of Yeo, I could immediately see one of the problems with the timing involved ▶

PHOTO 5: New floor supports and a repaint for carriage 17...

PHOTO 6: Floor supports going in – centre brace is where feet land when passengers get aboard...

PHOTO 7: ...followed by new floor panel.

PHOTO 8: Diesel 'Tony' is getting a new engine. *Photo: Andrew Charman*

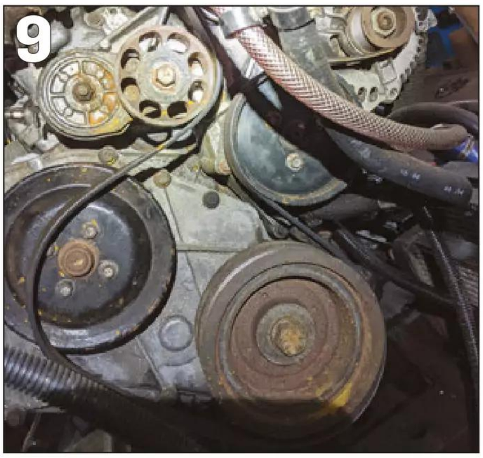
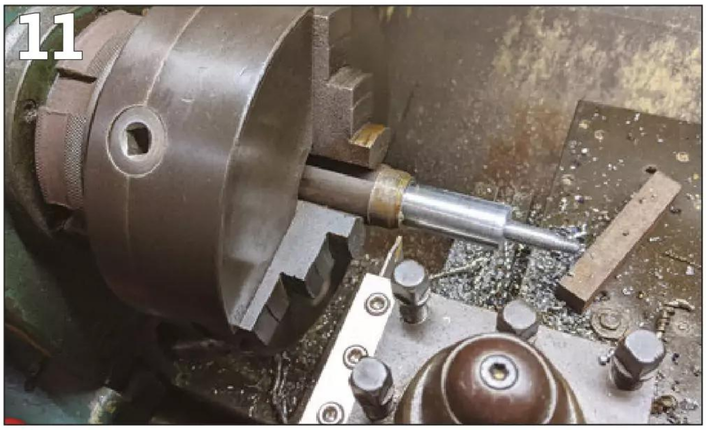


PHOTO 9: Land Rover engine for Tony, with centre bottom pulled needing removing.

PHOTO 10: Making up a tool to remove the pulley.



both the die blocks of the Walschaerts motion striking the bottom of the expansion links when the loco is in full forward gear, but not striking the top in full back gear.

On closer inspection, in mid gear the die block was sat 15mm below the centre point of the expansion link. This indicates either the reach rod is the wrong length, the crank onto the weigh shaft has moved, or the drop links are too long.

PHOTO 11: More lathe work – machining new damper supports for 'Gwirl'.

PHOTO 12: Dampers fitted – no more kangarooing!

PHOTO 13: 'Russell' creates a big puddle as its boiler is drained for the winter.

PHOTO 14: 'Yeo' in the shed and about to reveal motion horrors... *Photo: Andrew Charman*

PHOTO 15: Yeo's left-side motion, showing valve guide wear and original top-mounted grease nipple.

PHOTO 16: View into valve chest, showing valve rod wear.

PHOTO 17: Old and new rods, left one worn and slightly bent.

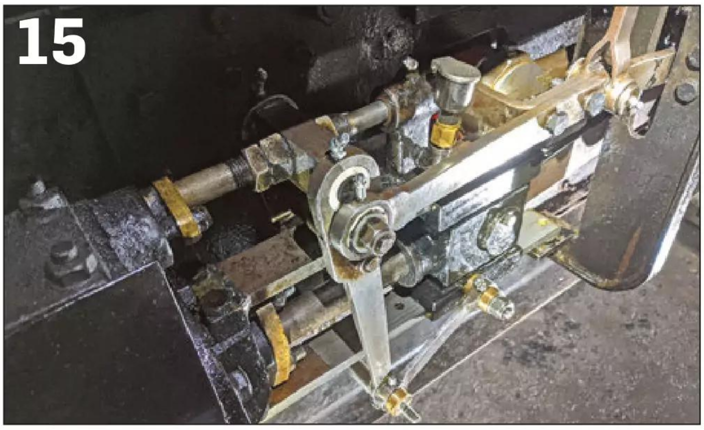
Having investigated the possibilities, it was either the drop links or the reach rod that needed adjusting. Since the reach rod was considerably easier to modify, I moved the hole that connects the reach rod to the reversing lever by 12mm, which brought the die block to the centre of the expansion link. When this loco is next rebushed, this issue will need looking at again as with the weight of the motion, any slackness will tend to bring the die block down.

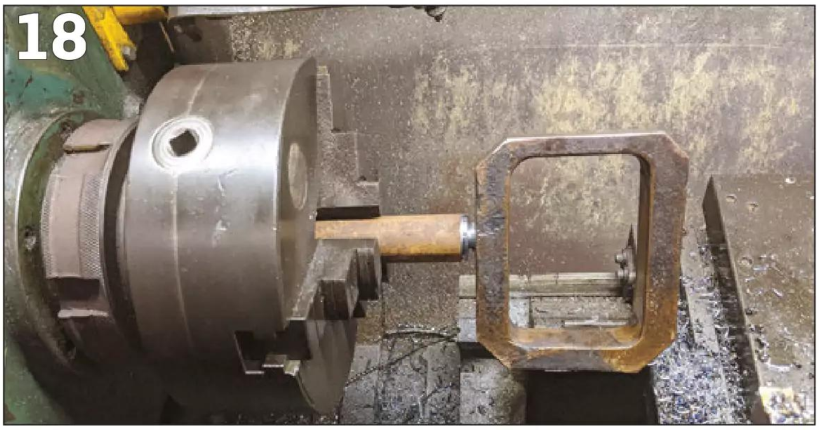
I then moved on to sorting out the leak between the valve chest and cylinder block. As this involved removing the valve rod and valve, as well as the valve guide, I took the opportunity to renew the valve guide bush and move the position of the grease nipple. Previously feeding from above, it now feeds from below, which should ensure that the highest wear area is properly lubricated.

Squaring the circle

As I was looking at the valve rod and measuring it up for a new bush, it soon became apparent that it was no longer round, so I put it into the lathe to return it to shape, only to find it was bent as well. Rather than try and straighten it, I made a new one!

Due to the design of the loco's main steam pipe, with a union inside the frames and a pipe stub leading through the frame plate and into the valve chest, there was no feasible way of removing the valve chest without taking off the entire main steam pipe





assembly inside the smokebox.

I decided instead to make a small modification and cut the pipe stub that went through the frame. I then tapped the entire depth of the side of the valve chest casting to 1-inch BSPP, before making a threaded length of pipe that would thread through from the inside of the valve chest, though the frames, and then thread into the union. I machined a pair of notches in the inner end of the threaded tube and made a simple tool to tighten it all up with.

While I had the valve off I put it on the surface table and ground it as flat as possible. At some point in the past the face has been made up with braze and then machined back flat, unfortunately not quite far enough so there are some small voids and the leading and trailing edges of the valves leave a lot to be desired. These will be rectified at a later date, along with a fair few other tired items I have discovered on this loco.

While I was working on Yeo, Kate, another of our volunteers, pressure-washed Sherpa's frames and running gear to get as much of the 10 years of accumulated grime off as possible before starting to strip the rods off and give them a layer of waxoil to protect them over the winter.

Thus ended the month of October, a very interesting and unusual one in many different ways! During the month I did also find time to make modifications to the small Colchester lathe, but I don't really have space to describe it properly here so this will follow in a separate article. EIM

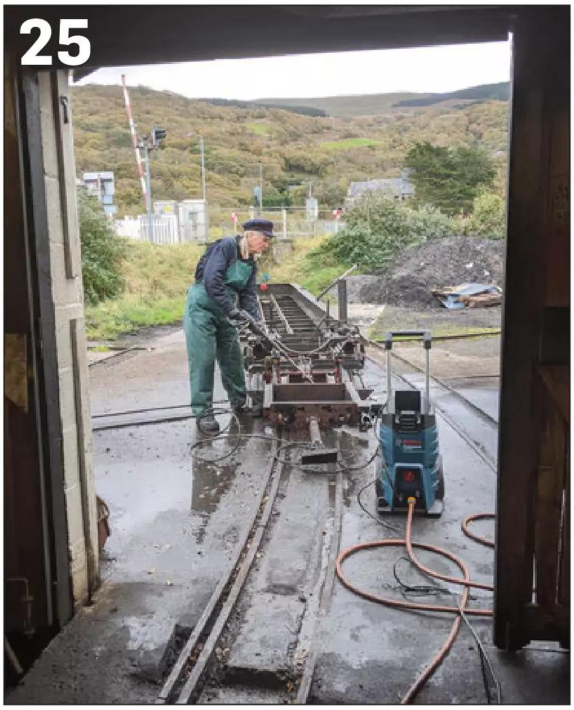


PHOTO 18: Making new valve rod, checking fit of thread on valve carrier.

PHOTO 19: Pressing in new valve guide bush, note aluminium to protect bronze from vice jaw.

PHOTO 20: New inlet pipework and union.

PHOTO 21: Fitting pipe using specially made tool.

PHOTO 22: Grinding the valve flat on a surface table.

PHOTO 23: Part done – note the wear marks and less than ideal edges and voids...

PHOTO 24: Scraping valve face flat – blue towelling roll prevents metal getting into cylinder bores.

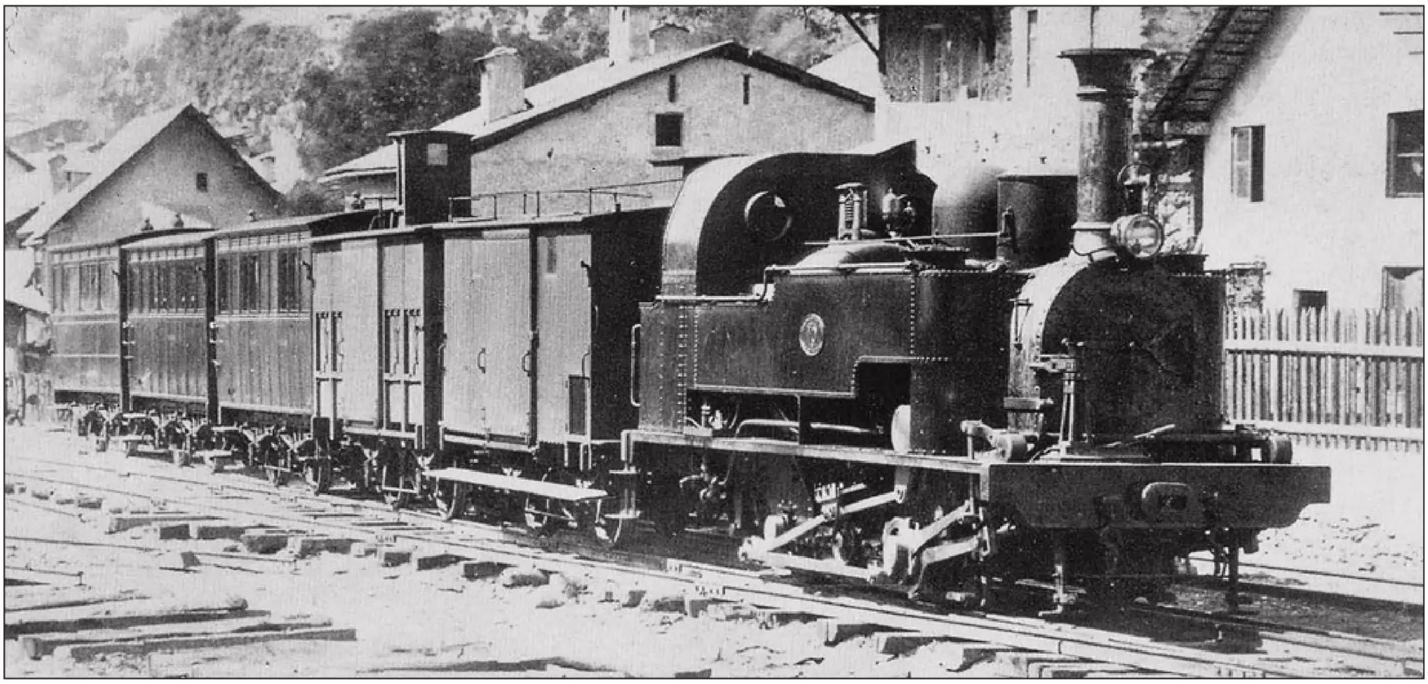
PHOTO 25: Volunteer Kate pressure washes chassis of 'Sherpa'.

PHOTO 26: Sherpa motion parts cleaned and wax-oiled.

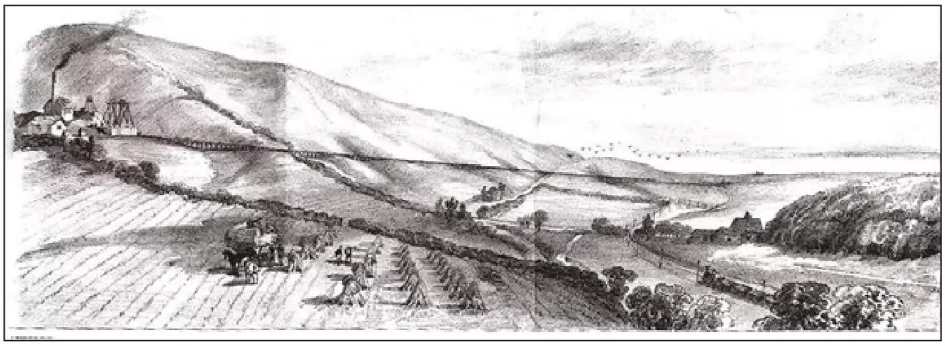
Fell Country

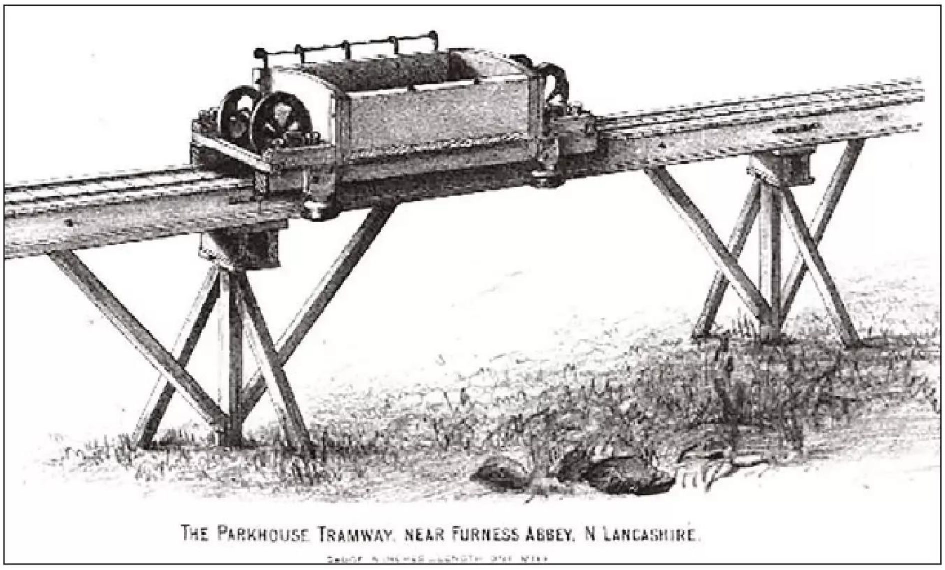
Rodger offers an insight into a unique rail system specifically designed for climbing steep gradients without resorting to a rack.

BY **RODGER BRADLEY**



ABOVE: The very first commercial application of the Fell System was on the Mont Cenis Railway in the Italian-French border area. The raised centre rail can clearly be seen in this view along with a motley collection of four-wheeled coaches. *Photo: Unknown author, via Wikipedia Commons*





If you were ever a train spotter in Britain in the 1950s and '60s, chances are the only 'Fell' locomotive you knew about was a complex diesel-mechanical design from 1951, attributed to the innovative ideas of Lt. Col. L. F. R. Fell. The locomotive carried four 500hp Paxman diesels, and a 'steam-era' mechanism of gears and coupling rods, to transmit the drive to the wheels, all in an attempt to reduce axle loading, and operating/ maintenance efficiency.

But, and it's a very big but – this particular 'Fell' design was neither the most famous, nor the most successful – that honour was awarded to an engineer from 1863 by the name of John Barraclough-Fell. The whole design – both of the track, and the steam locomotives – was intended for use on steeply graded mountain and mineral railways.

Now, it would be prudent at this point

ABOVE LEFT: Where it all began – an engraving from *The Engineer* in 1870, showing Fell's earliest project for a tramway running from the Furness Railway's main line to an iron ore mine. The September issue of that year also included a proposal for an elevated passenger tramway in Lausanne.

LEFT: From the same edition, one of the 'mineral waggons' to transport ore from the mine to the nearby railway station. Here though, the guide wheels are shown on the side of wagon, and overhang the track.
Images courtesy The Engineer

to say, why not use one of the well-known rack systems and toothed gearing? Well, when Fell began his work in the 1850s and 1860s rack systems were yet to be invented.

The later rack railways might have evolved ideas from John Blenkinsop's locomotive with its toothed wheels, but for narrow gauge, mineral and other lines, the system devised by John Fell used a raised, third rail, in the centre of the track, to be gripped by additional wheels mounted below the locomotive.

The steam locomotives used on these systems had two sets of cylinders, the primary ones powering the coupled wheels, and a second, or auxiliary pair used to drive the horizontal wheels that gripped the centre rail. This was the system developed and introduced by an engineer who spent his formative years in and around Lakeland – John Barraclough Fell.

Fell was born in London in 1815, moved to West Cumberland (now part of Cumbria) in 1835 and in the early 1840s was at work on the mineral lines of the Cumberland coast. In addition he worked with and for the Whitehaven and Furness Junction Railway, although not in connection with any proposal to construct a line through, across or over Lake District fells or mountain passes. By the 1850s, John Fell was living in Italy, and became closely involved in the building of a new railway over the Mont Cenis pass, to link Italy and France by rail.

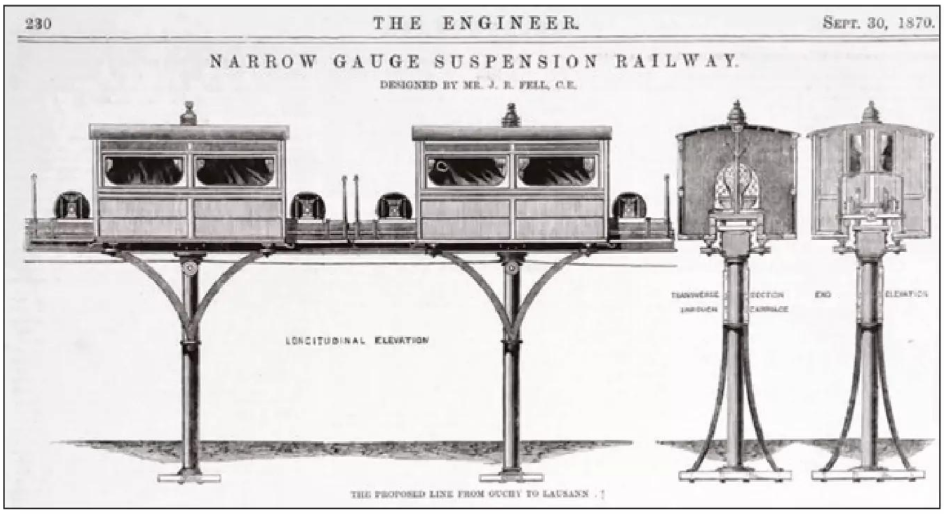
Early Trials

Fell's invention – it was patented in 1863 in both England and France – was tried on the Cromford and High Peak line in Derbyshire, but also in the iron mining district of Furness, in North Lancashire. This was an experimental mineral line, and laid out in 1868, from a siding provided by the Furness Railway at Roose. It was built to connect to the rich iron ore deposits at the Yarlside mines, a mile away from the Furness Railway's main line, and was initially a horse-drawn line.

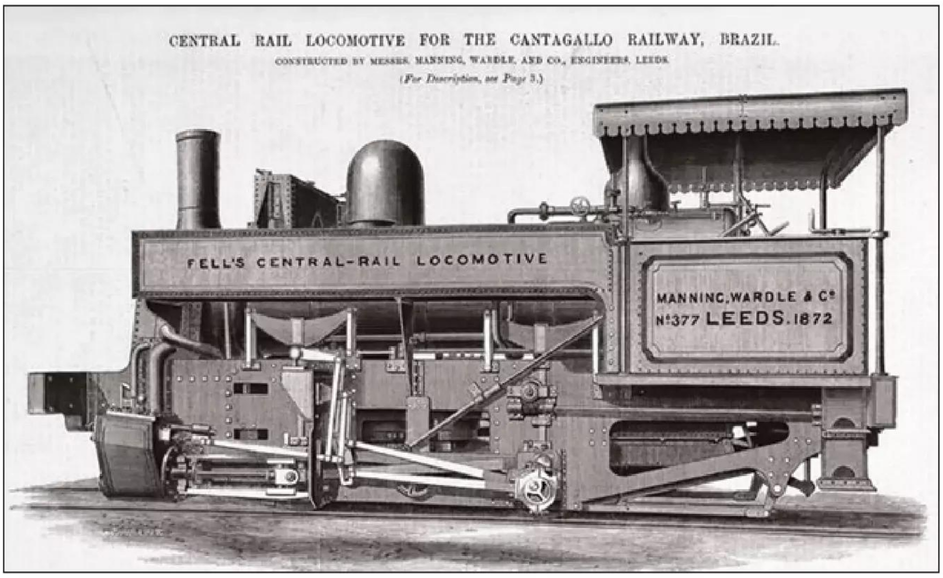
A couple of years later, Fell built the Yarlside Iron Mines Tramway, this time an elevated tramway, with an endless steel hawser, pulling the waggons across the 8-inch gauge line. The tramway was described at some length in the issue of *The Engineer* magazine published on 30th September 1870.

The Fell system's initial advantage over other rack-bsed designs was that the third rail was not toothed, but rather a smooth bar/rail that was 'hugged' by a set of horizontal wheel pairs mounted under the special locomotives built for the system.

The concept in application was clearly intended to speed up railway building in hilly, or mountainous areas – the ideas expanded to include special-purpose and military applications, and it was decided that this principle could be applied to larger, standard and metre gauge railways, as on its first commercial application to the Mont Cenis Railway. Later its advantage on ▶

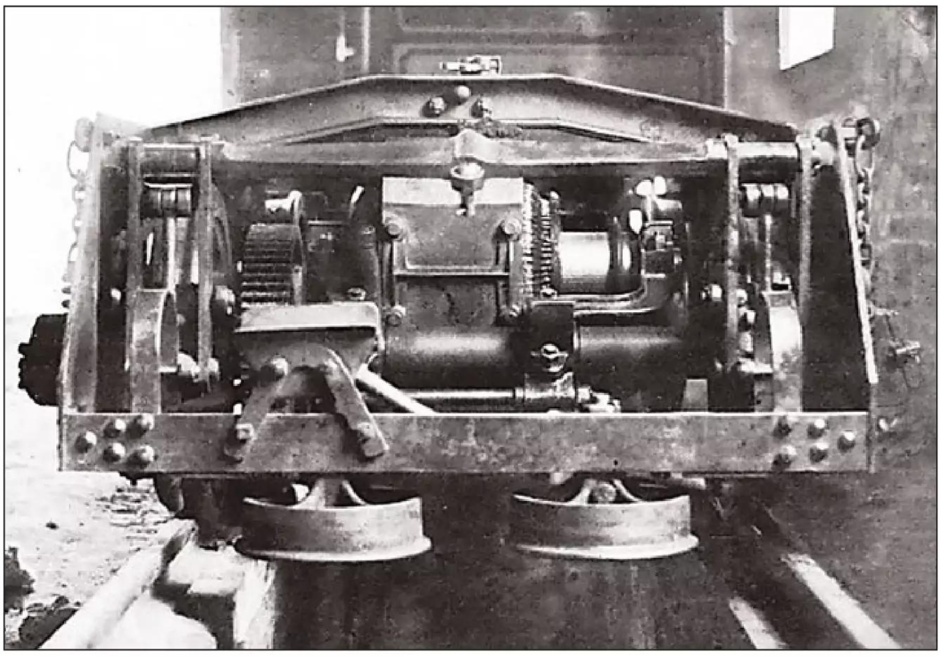


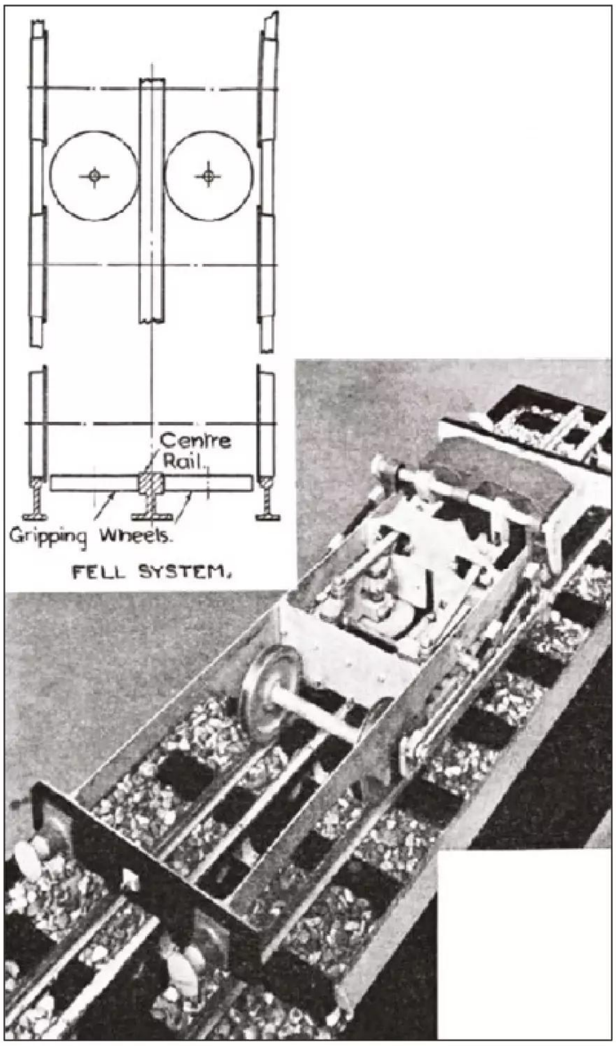
ABOVE: Another of Fell's proposals was this venture near Lausanne in Switzerland.
Images courtesy The Engineer

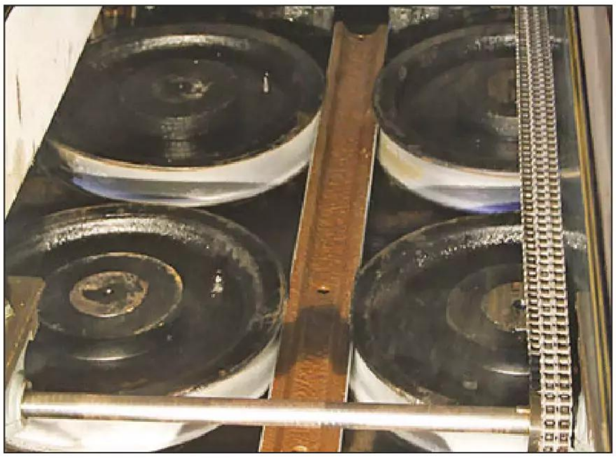


ABOVE: The first Fell design locomotives for the EF Cantagallo Railway, Brazil were built in Leeds by Manning Wardle. *Image: www.railwaywondersoftheworld.com*

BELOW: This view underneath the Manning-Wardle built Fell engine clearly shows the horizontal wheels that grip the centre rail. It would undoubtedly looks be a complex project for a model engineer. *Image: www.railwaywondersoftheworld.com*







"The third rail is not toothed, but rather a smooth bar/rail that is 'hugged' by a set of horizontal wheel pairs mounted under the special locomotives..."

LEFT: General view on a model of the workings on a 'Fell Centre Rail' loco., with the diagram inset showing basic operational principles.
Image courtesy: www.railwaywondersoftheworld.com

LEFT: Rarely seen view of the inner workings of a steam loco built for the Fell System – the wheels that 'grab' the raised centre rail are clearly shown in this view. In later years the system was modified so that the locos only used the centre rail for additional braking purposes and not to provide extra adhesion. This 'Modified Fell' is fitted to a locomotive used on the EF Cantagallo Railway, Brazil.
Image courtesy http://mestreferroviario.blogspot.com

BELOW: Fell locomotive climbing the Serra do Mar, a difficult and long ascent on the EF Cantagallo Railway, Brazil.
Image courtesy http://mestreferroviario.blogspot.com

standard-gauge routes would disappear, particularly as more conventional rack systems advanced.

First in Europe

The Mount Cenis Railway was to be financed entirely privately, and following the formation of the Mont Cenis Concessionary Company in 1864 permission was requested from the French and Italian governments to build the line. It was to include space for a road alongside, which created some construction challenges along the way, especially in many places where the trackbed was built on a shelf on the side of the mountain.

Overall, the railway was 77 kilometres (48 miles) long, with a gauge of 1,100 mm, and designed by John Fell to incorporate his newly developed three-rail adhesion system. The railway was built as the Mont Cenis Railway Company (Limited), with locomotives intended to be constructed at Brassey's Canada Works, in Birkenhead. However French law prohibited the import of these and Ernest Goüin et Cie of Paris was used instead.

The Fell System described in *The Engineer* in 1870 introduced the possibility of even more innovative designs for what Fell described as narrow gauge, and smaller, for areas where populations were sparse or access difficult. At the same time these narrower than narrow gauge designs, with an 8-inch to 18-inch gauge, were being proposed they were described as being cheap to build and operate, despite being suspended on timber or steel supports.

The Mont Cenis Railway and its related proposals were not the only innovative designs Fell produced for European railways, while he also suggested that proposed mountainous routes in India – especially the Ghats surrounding Mumbai (Bombay) – could be climbed more easily, and cheaply using the Fell System. The system was also proposed for use in Spain and Italy.

Coffee from Brazil

Following the success of the Mont Cenis Railway, Fell's next application was in Brazil. One of only two Fell Railways to be built in the Southern Hemisphere was the Estrada de Ferro Cantagallo (EF Cantagallo), which opened for traffic in 1873. This was Brazil's first mountain railway, and was built to transport coffee from the plateau area down to the coast for export to the rapidly expanding global coffee market.

The railway, of 1,100mm gauge, ran from Niteroi on Guanabara Bay, opposite Rio De Janeiro to Nova Friburgo, a distance of a mere 130km (85 miles), but climbing from sea level to almost 845 metres (3,000ft), by means of very steep gradients and sharp curvatures. The maximum gradient was 1 in 12, and the sharpest radius curve between 33 metres (111ft) and 100 metres (328ft.).

The Cantagallo Railway purchased

three new 0-4-0 steam locomotives from Manning Wardle's Boyne Engine Works in Leeds, but these were very lightweight engines of only 14 tons, and they certainly needed the extra adhesion from the centre rail to haul any vehicles up the gradients.

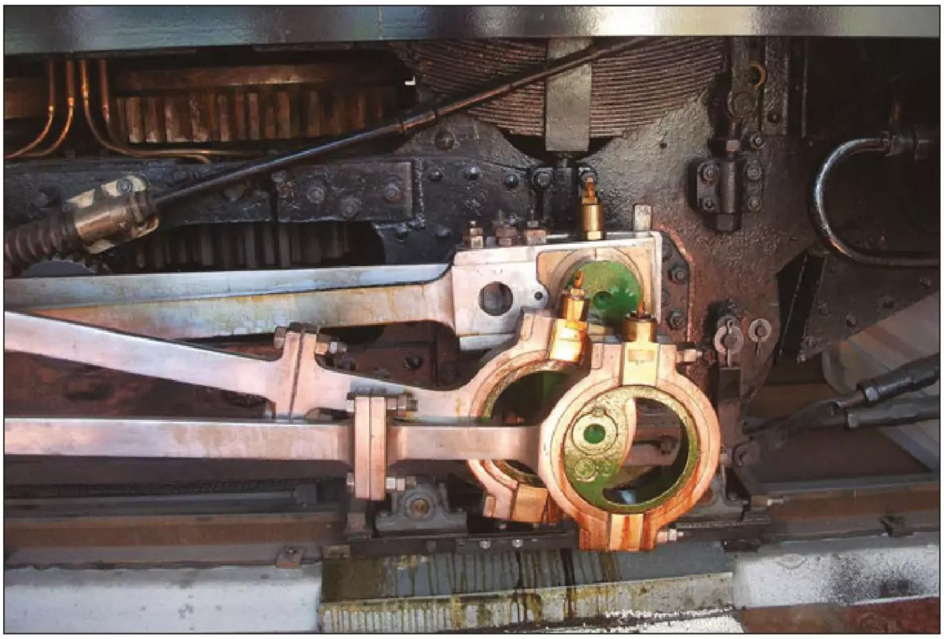
A mere 10 years later, the Cantagallo Railway ordered much bigger engines from Baldwin in the USA, weighing in at 44 tons, and these did not carry the Fell equipment. By that time, the Fell system was retained merely for braking purposes, with the locomotives having sufficient weight and power to operate as adhesion only.

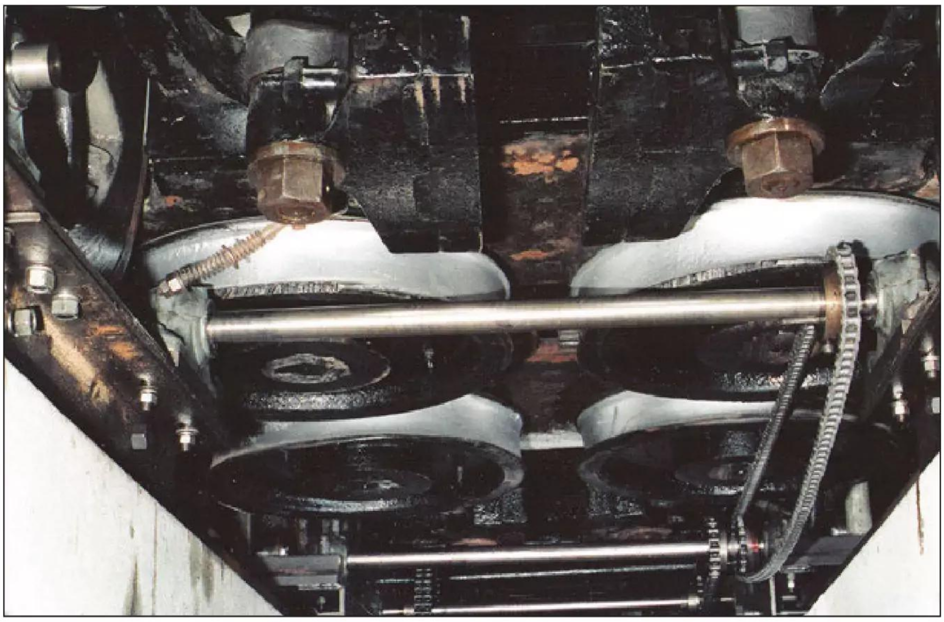
The Rimutaka Incline

The Rimutaka Incline was a short but spectacular section of railway between Wellington and Masterton on New Zealand's North Island. It was a 3-mile long (4.8 km), 3ft 6in (1,067 mm) gauge line with an average gradient of 1 in 15 between Summit and Cross Creek stations, opened in 1878 and closed in 1955. The incline was part of the 107 miles (127km) Wairarapa Line, over the Rimutaka Mountains, taking the railway into the sheep farming and dairying district of the Wairarapa Plains.

The incline itself was constructed under two contracts, one for the Summit station, yard and tunnel, with works carried out by the New Zealand Public Works Department, with the second contract for the incline itself. The incline was the direct route, but since rack and pinion technology was not fully developed, and to meet the requirements on the Rimutaka in the 1870s, the Fell System was deployed.

In 1874, the Avonside Engine Co. in Bristol found itself with an order for four locomotives fitted with the Fell equipment, and the centre rails that would be fitted to the track. In 1886, two further locomotives arrived at the Rimutaka line from Neilson & Co.'s Hyde Park Works in Glasgow. All six were 0-4-2T, and 'Class H', with running numbers 199-202 (Avonside), and 203-204 (Neilson). They weighed in at just ▶





TOP RIGHT: Preserved Rimutaka loco H219, in the Fell Engine Museum in New Zealand. *Photo Simon Robinson/Wikipedia Commons*

UPPER RIGHT: Close-up of the motion of H219, note the large cog wheels of the Fell system between the frames. *Photo courtesy George Watt*

RIGHT: superb underneath view of H919, clearly showing the double flanged 'gripper' wheels, and nearest the camera the cast iron brake blocks that provided additional braking effort for these unique locomotives on the downward trip. The brake blocks were replaced after each trip, and similar blocks were included in each train's brake van. The chain drive actually has nothing to do with the Fell System, but is part of an electrically driven mechanism that turns the wheels to demonstrate the system in action for museum visitors. *Photo: George Watt*

"Each loco had four cylinders, with two driving the rear pair of coupled wheels, and the other two driving the spring-loaded gripper wheels..."

TOP LEFT: The central Fell rail is clearly visible in this view from a tram car ascending the 3ft 6in gauge Snaefell Mountain Railway on the Isle of Man. Originally intended for both traction and braking, the Fell Rail system has only ever been used for the latter, and today forms a back-up to an electrical braking system.

LEFT: Two views showing the gripper wheels and brake grippers on a SMR tram car.

BELOW: Snaefell tram car No. 5 is about to arrive at the Summit station. As can be seen the use of the Fell rail is today not universal on the line, more level sections doing without it. This proved unfortunate in March 2016 when car No. 3 was insufficiently braked while standing at Summit station. The empty tram car ran away and when it reached the first significant bend in the track rolled to destruction.

Photos: Andrew Charman

under 40 tons. Each loco had four cylinders, with two driving the rear pair of coupled wheels, and the other two driving the spring-loaded gripper wheels for the centre Fell rail.

The first of the class, H199, was the only member rescued for preservation, and remains today at the Fell Locomotive Museum in Featherston, New Zealand as the only surviving steam locomotive of its kind. Ironically perhaps, H199 also carried the name 'Mont Cenis' – a marked reference to the first application of the Fell system to a mountain railway.

Thankfully this example of a unique and highly innovative railway design survives, while closer to home is an example of a Fell system still in operation, though not steam powered.

Family legacy

The 3ft 6in gauge Snaefell Mountain Railway on the Isle of Man was originally surveyed in 1888 as a steam-operated line by George Noble Fell, son of John Barraclough Fell, and he intended to use his father's system for both traction and braking. However by the time the line was built and opened in 1895 it was an electric tramway with the central Fell rail only used for braking – today that rail survives though as a back-up to modern electrically powered rheostatic brakes.

In 1995, for the line's centenary, a third rail was laid allowing 3ft gauge Isle of Man Steam Railway loco 'Caledonia' to run on the Snaefell line, the same loco having assisted in construction in 1895. For the event the loco was fitted with a Fell brake.

Meanwhile the work carried out by John Barraclough Fell on the Furness Railway, the Yarlside Mines near Barrow-in-Furness, and from Switzerland to Brazil and New Zealand remains an important tale in railway history.

This innovative piece of railway engineering would be a challenge for anyone to reproduce in miniature model engineering scales, but imagine the system running on one of the many outdoor miniature lines around the country. Maybe a larger gauge – and perhaps on the scale of the 7¼-inch gauge Millerbeck Light Railway in the Lake District – but this would be something of a challenge whatever the project. EIM

Useful Links

- http://wairarapapast.blogspot.com/2012/02/gully-john-1819-1888-mountain-railway.html
- www.facebook.com/photosoldwellington region/?ref=page_internal
- https://oldphotos.co.nz/nz-north-island/wellington/
- www.rimutaka-incline-railway.org.nz/news/cad-design-work-begins-wb-locos
- https://museumsandgalleries.leeds.gov.uk/leeds-industrial-museum/
- http://mestreferroviario.blogspot.com/2013/04/ferrovias-apertadas-iii-linha-do.html
- www.railwaywondersoftheworld.com
www.gracesguide.co.uk/Main_Page

Additional support on the milling machine

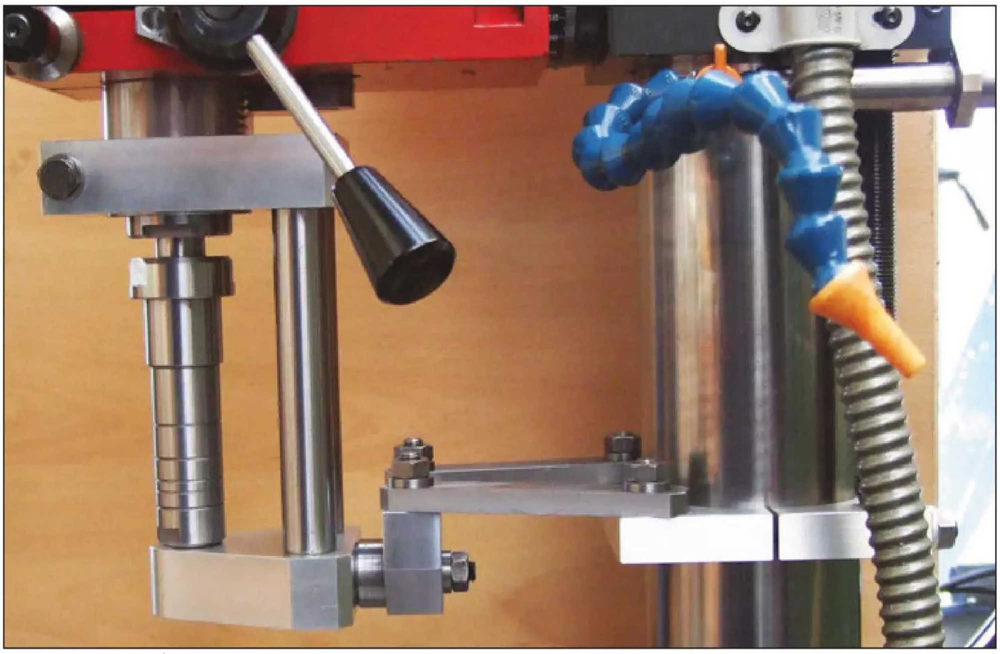
Graham's latest addition to his Emco FB2 mill expanding its capabilities can like previous enhancements be easily adapted to suit other machines.

BY **GRAHAM MEEK**

A job cropped up some time ago that involved cutting a new gear for a friend's four-stroke stationary engine; the Diametrical Pitch (DP) of this gear was what I would normally consider outside the scope of my Emco FB2 mill. But having recently designed a new quill assembly which replaces the needle roller bearing of the original fitment with a taper roller bearing in a completely new quill on my machine, plus already having an overarm support attachment made sometime ago and described in Chapter 13 of *Projects For Your Workshop, Vol 1*, (TEE Publishing). I thought this would be a good project to try out the new bearing arrangement.

I include photos of the redesigned quill assembly just for information, Photos 1 to 3. While the FB2 coped with the work in hand the finish was not as good as I had expected, luckily I did not go to full depth on the first cutting pass – with such large DPs it pays to take several cuts.

Following the subsequent cuts to hit size the surface finish did improve. My friend was impressed with the gear, and said tongue in cheek that it made the other gear look a bit shabby. This was clearly the precursor to a request to gear cut the other gear, which I said I would do.



HEADING: The completed quick-release bracket in normal position.

PHOTO 1: Conversion components for the redesigned quill assembly.

PHOTO 2: Bought-in components for the assembly.

PHOTO 3: The quill once fully assembled.

All photos and diagrams in this feature by the author

While my friend was away machining another blank for the other gear, I reviewed the overarm set-up. In the good old days horizontal milling machines supplied to industry had a knee brace. This usually took the form of a casting that was clamped to the knee of the machine. Most were clamped across the slideways on the knee.

In the upper portion of these braces the casting had one or two slots that went over a stud, or studs on the overarm arbor bearing support. Once the machine was set to the required depth of cut the stud(s) would be tightened along with a brace clamping arrangement on the knee as well as the knee itself, thus a very rigid box-like structure was formed.

In passing it is interesting to note that Edgar T Westbury, (ETW), in his ▶

original design for his light vertical milling machine that later became the Dore-Westbury milling machine included a tapped hole on the front of the quill head casting, for attaching a couple of slotted braces going down to the base casting of the vertical mill. He had clearly thought about this problem during the design stage.

Given the time taken to achieve an acceptable finish on my friend's gear by using the additional cuts, I decided that some additional support would be of benefit on the FB2 overarm. Therefore before the overarm was packed away for the time being, two M8 tapped holes were machined in the end of the support bars – **Photos 4** and **5** show the setup to do this.

Having worked closely to the nominal dimensions while making the original overarm during the construction, the setup is quite easy as all the parts are in line and can simply be bolted to an angle plate with a couple of strap clamps. It was then just a simple matter of coordinate location to determine the true centres of the overarm support bars – however any error of the order of 0.1 to 0.2mm off centre is not really going to matter.

Of course if the reader is making the overarm from scratch these M8 tapped holes can be easily machined during the manufacture of the support bars. The tapped holes will however need to be relieved for the first couple of threads to provide a suitable centre to finish machine the support bars, see the enlarged view on the drawings for details. This form of thread relief also makes the insertion of a short M8 bolt much easier when the unit is on the milling machine and these tapped holes are out of sight.

PHOTO 5: Over-arm set up against angle plate, using edge finder to locate vertical face.

PHOTO 6: About to drill second hole.

"This approach would call for some very complex joints to allow for the cross slide movement"

Design considerations

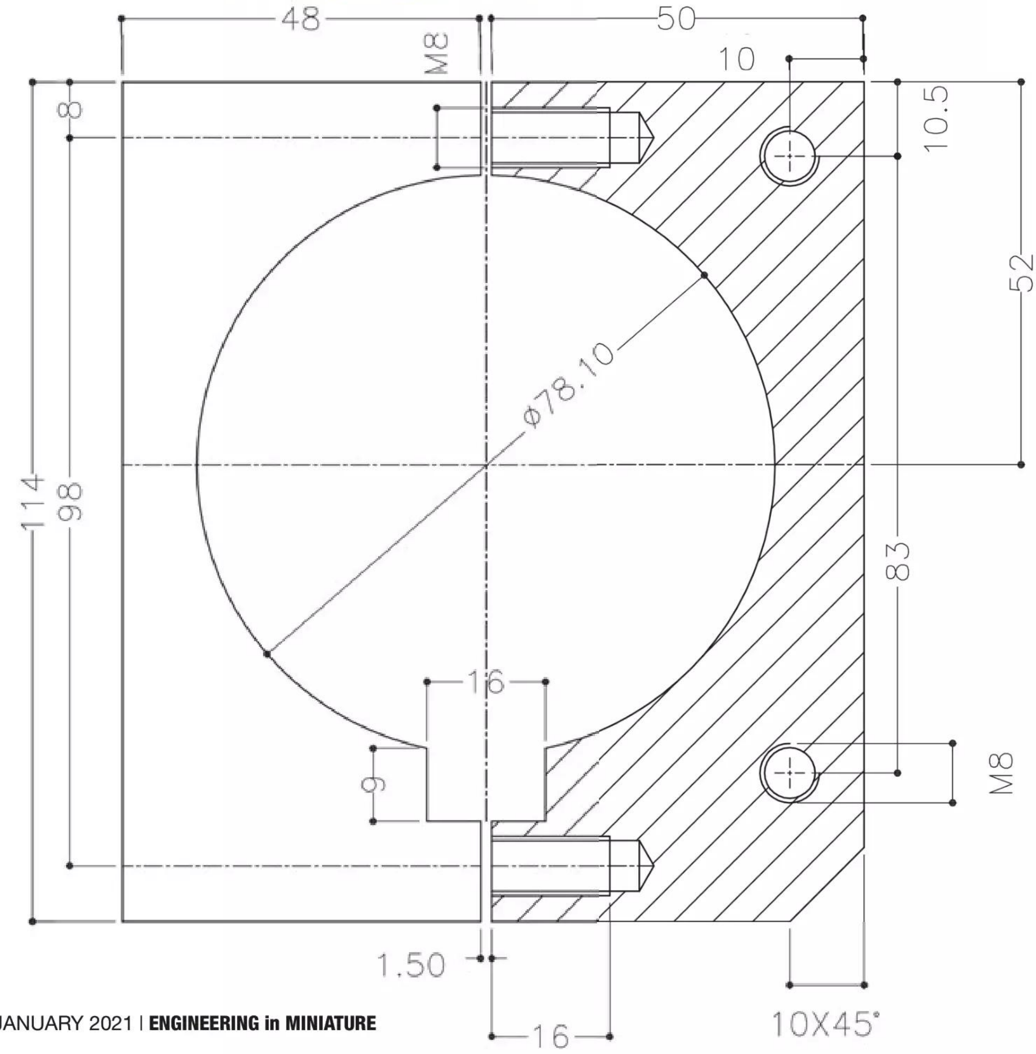
Having drilled and tapped the two M8 holes in the overarm, my attention turned to the design of the additional support. With the head rising and falling on the vertical column any additional support would need to be anchored to this column.

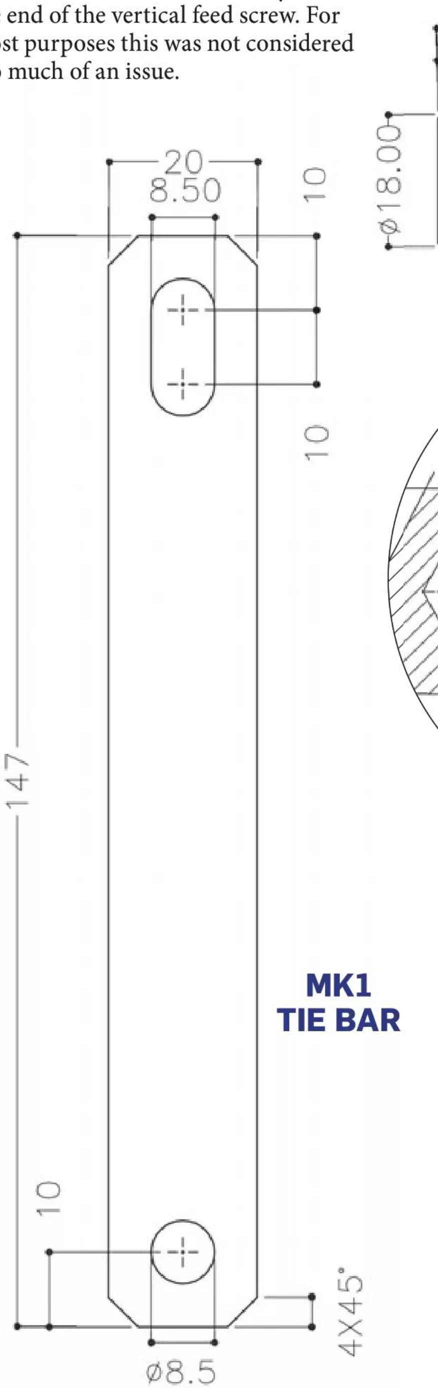
Adding slotted braces down to the cross-slide of the milling machine similar to ETW's design was not an option as all the possible mounting faces on the cross-slide move in and out with the cross-slide. I am not saying this could not be achieved, but this approach would call for some very complex joints to allow for the cross slide movement. There would likely be no real gain due to all the interfaces introduced, while the versatility of the milling machine would be severely restricted by making it impossible to rotate the milling head about the column centreline. This is often needed when the gear being cut needs to hang over the back edge of the milling table, as the gear is too large for the dividing head centre height.

Initial thoughts were to add a simple round split clamp to the base of the milling machine column. However due to the rectangular alignment key strip that guides the milling head and runs almost the entire length of the column, this would restrict the vertical range of movement that this simple type of clamp could provide.

Making a rectangular-shaped split clamp would allow the one clamping stud to be moved over sufficiently for a portion of the clamp to be milled away and provide clearance for the rectangular key strip, **Photo 6**. This would allow a greater range of movement but would eventually foul the end of the vertical feed screw. For most purposes this was not considered too much of an issue.

COLUMN CLAMP
Drawings approx full-size



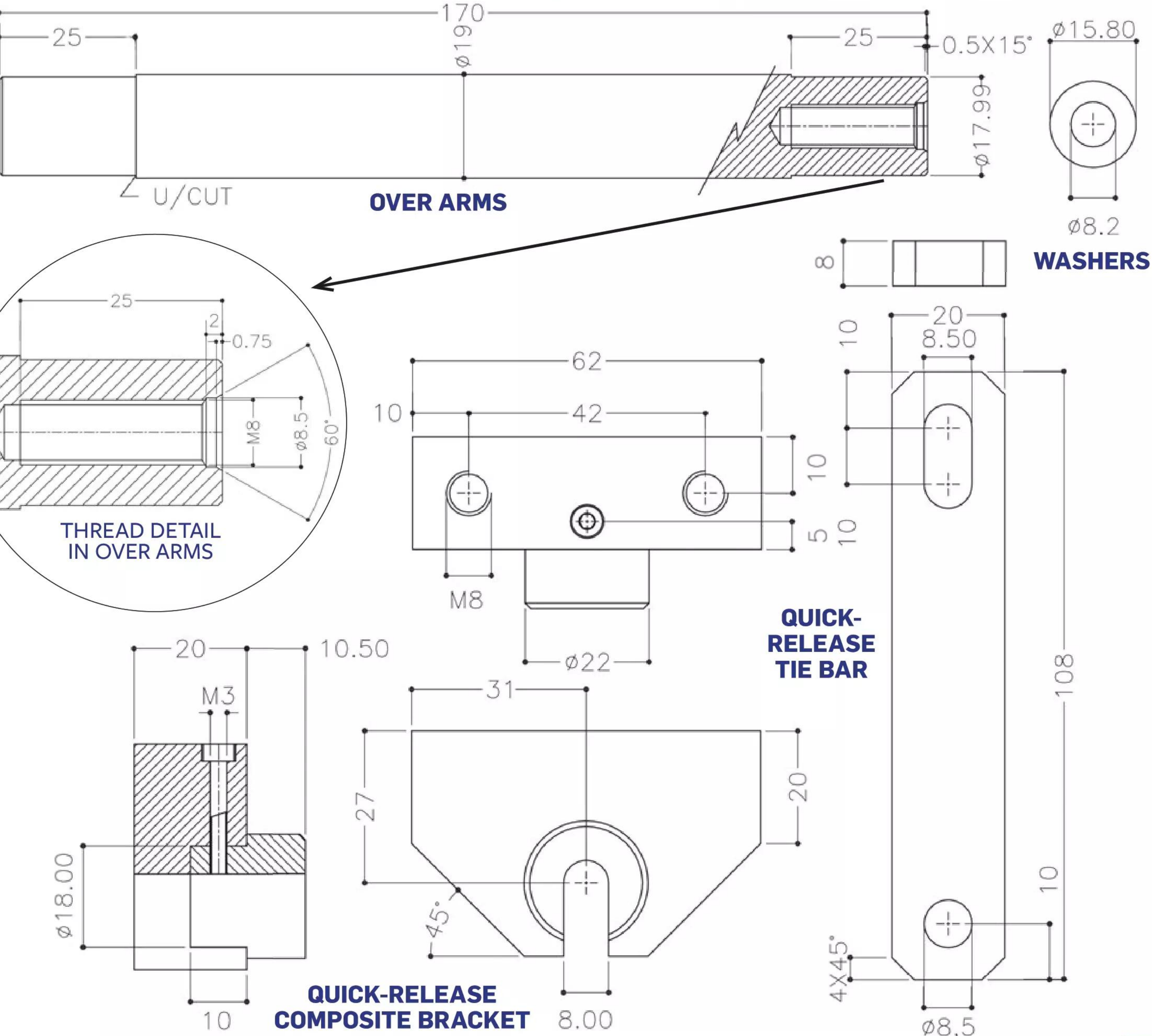


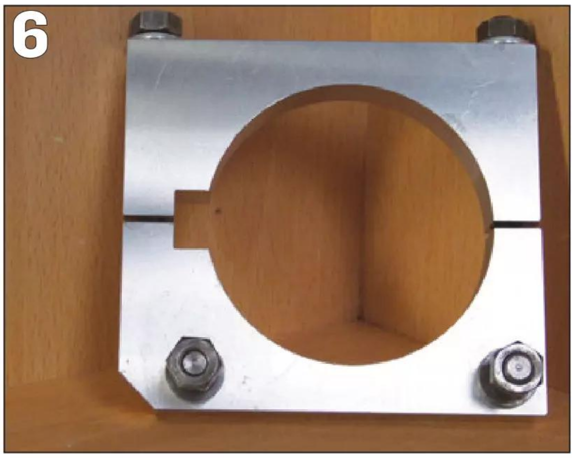
MK1 TIE BAR

Thinking further about this fouling problem I was eventually able to come up with a contingency plan to allow a further extension of the range of movement – more on this later.

The clamp shown in the drawings was manufactured in aluminium – there is no reason why cast iron or BMS could not be used, but the latter would in all probability distort heavily with such a large bore. At least with aluminium any debris which has escaped the cleaning process before fitting the attachment is more likely to damage the aluminium and not the ground surface of the column.

The embryo split clamp halves were machined to overall length and thickness, but left oversize on the width by 0.75 mm. One half was then drilled using coordinates to accept the clearance holes for the retaining studs, whilst the other half was drilled and ▶





tapped M8. The two halves were then clamped together, ensuring that all the edges were perfectly aligned with a couple of slave bolts in order to machine the bore to size. This bore was purposely made oversize by 0.1mm (0.004-inch) to ensure the parts were not too snug a fit – such that they became difficult to assemble, or would not move easily during the final stages of setting-up.

I made the bore in the column split clamp with a boring head in the milling machine, after removing much of the waste material by chain drilling using coordinates. Alternatively the bore can be machined in the lathe after first locating the centre by coordinate location, as I have described in previous articles.

Whichever method is used, ensure that the upper clamping surface of the column split clamp is square in both planes to the column bore. The reader won't want this attachment to ruin the alignment of the overarm itself, whereby imposing an off-set loading to the spindle bearings due entirely to a loading being imposed between these two mis-aligned attachments.

This is one of the reasons I chose to machine my bore on the milling machine with the work clamped down on parallels on the machine table. In the lathe a final light skim across the face of the column split clamp after the bore is finished will take care of this requirement, provided the upper surface is outermost when mounted in the four-jaw chuck.

Note that there is a 1.5mm gap between the two halves of the column split clamp when this is assembled onto the milling machine column. This was the reason for leaving the additional material on the width of the clamp, thus avoiding an interrupted cut during the boring operation, the two halves of the clamp in the machine vice with the 'ears' to be machined uppermost.

A cut can be taken across the two exposed ears to remove this unwanted material, if care is taken while setting up the work in the milling machine vice, such that the two halves are exactly side-by-side. Then the cut-out to miss the column key strip can also be milled away at the same time.

PHOTO 6: Completed column clamp.

PHOTO 7: Mk1 tie bars in position.

PHOTO 8: Here the over-arm is slewed around such that the flat on the lower bearing support is parallel to the Y axis.

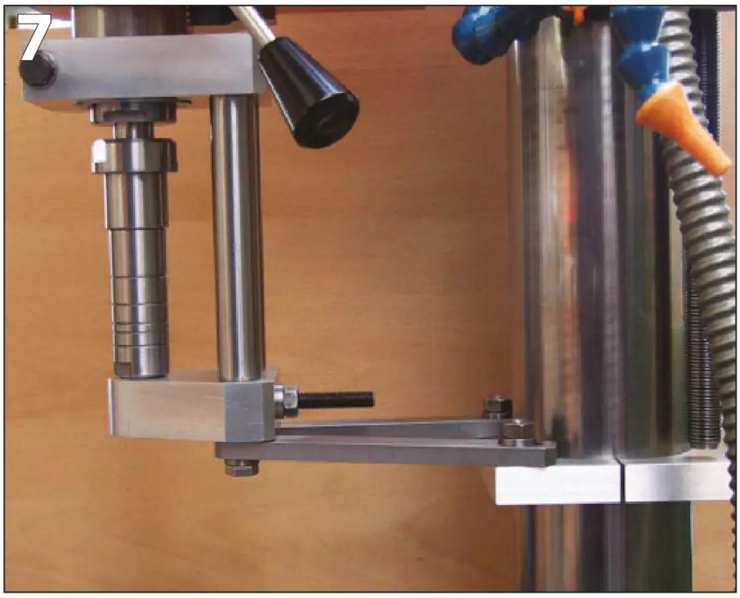
PHOTO 9: Quick-release bracket in its inverted position giving additional range of use.

Tie bars

To connect the overarm to the column split clamp all that is required are two rectangular section BMS tie-bars, Photo 7. Those shown on the drawing have a short slot at the one end. It is possible to get away with just two plain 8.5mm drilled holes at each end, but this does mean that the over-arm and the column split clamp needs to be fairly accurately aligned initially before clamping.

If however the overarm should need to be rotated slightly about the quill in order that the lower bearing support of the overarm does not foul say the dividing head chuck, then a two-drilled holes approach will not permit this. The two slots shown in the tie-bars allow the overarm to be rotated sufficiently for the flats on the lower bearing support of the overarm to be brought parallel with the Y-axis motion, Photo 8. Further additional clearance can be gained by rotating the whole milling head and column on its axis, by releasing the column base casting clamp.

As mentioned earlier I had envisaged a plan to gain a larger range of usage further up the machine column, when the column split clamp had run out of adjustment by hitting the bottom of the vertical feedscrew. This is achieved by adding some 25mm diameter tubular spacers between the column split clamp and the two tie-bars. It will of course be necessary to use longer studs in the split column clamp for this new assembly. The spacers could be manufactured as required, or a set of incremental spacers made beforehand and built up to suit, similar to the use of slip gauges.



This without the additional spacers was the Mk1 set-up used to machine the second gear blank for my friend's stationary engine, but when it came to doing several different gears for my 10cc four-stroke diesel engine continual removal of the tie-bars to change the gear cutters for the various numbers of teeth started to become a little tedious. I decided to seek a further refinement to the original design to ease my tedium.

The final design you see in the heading photo to this feature is I think the best of both worlds. But should I have only one gear to cut in future then the initial Mk1 design would still be used, simply because the parts are to hand and because there are less clamping interfaces involved – the simplest solution is always the best.

Expanded use

There was an unexpected use for this second version never envisaged at the design stage. Recent manufacture of a helical worm gear required that the milling head be canted over at the worm helix angle in order to gash the gear teeth. Because of the single-point attachment of the quick-release version this was possible, even though the milling head was leaning over. Of course there are limits as to how far this can be taken without having to manufacture additional tie-bars.

This second solution uses two shorter tie-bars, but these still retain the short slot in the one end to allow for the overarm to be pivoted about the quill centre-line. The tie-bars attach to a composite aluminium block that fits over a longer stud in the overarm lower bearing support.

I considered using a piece of aluminium angle about 6mm thick in place of this composite aluminium block. However as the gripping action of the overarm lower bearing support originally relies on a localised distortion of the clamping area between the two overarm bars, using the aluminium angle across the whole face of the overarm lower bearing block would not give this localised clamping action.

Therefore to ensure a localised clamping area on the lower bearing support a mild steel spigot is pressed into an aluminium block. This spigot does not go all the way through the block but stops short of the rear clamping face by 10mm. By doing this it is assured that the clamping force is transmitted to the aluminium block, and not just to the spigot.

An additional M3 capscrew is used to further retain this spigot as later a slot will be machined in the lower face of this composite block to ease the removal of the lower bearing support of the overarm. The additional capscrew ensures that there is no movement of the steel spigot during this milling operation.

Both the spigot and the aluminium block are pre-drilled to 7.9mm diameter prior to assembly – this then allows the two parts to be pulled together using a piece of M8 studding, or Allthreads. As well as making the job easier this roughly aligns the parts during assembly.

Prior to assembly the steel spigot was smeared with some Loctite 603 – even with a press fit, applying a drop of Loctite will stop the two dis-similar metal parts 'picking-up'. Should the press-fit be not quite what one was expecting, then the Loctite should make up the deficit.

After the two parts are together the M3 counterbored tapped hole was machined and the M3 by 20mm long capscrew inserted with more Loctite Studlock or similar. There is no reason why this cannot be a 6BA capscrew if these are more readily available.

The block is then held in the milling machine vice and the 8mm wide slot opened up using a 7 or 7.5mm slot drill. The drill is moved off-centre each way to leave about 0.1mm on each slot face after which the machine spindle is returned to the slot centre-line. Then exchange the slot drill for an 8mm ball-ended, or ball nose cutter. This cutter is fed straight through at the required depth.

Not too tight a fit

Before the work is removed from the machine vice try the fit of the new longer M8 stud in the lower bearing support. If it feels a little on the tight side, or as if it will not be easy to assemble or remove when in use, then it would pay to take an additional 0.1mm off each face, thereby adding a slight clearance. A lot will depend on how straight the new stud is, and whether it is exactly square to the clamping face when inserted into the lower bearing support.

The type of fit will also depend on whether the reader has used M8 studding, Allthreads, or has actually made a stud using bar stock, which is threaded at each end. This is one reason why I have not specified a specific clearance on the drawing.

Again to increase the operating range of this version additional cylindrical spacers can be used in conjunction with longer studs fitted to the column split clamp. It is also possible to use the second brace the other way up to gain additional operating range. I have included a view (Photo 9) of this arrangement, but with the composite bracket configured in this way the quick-release facility is not available.

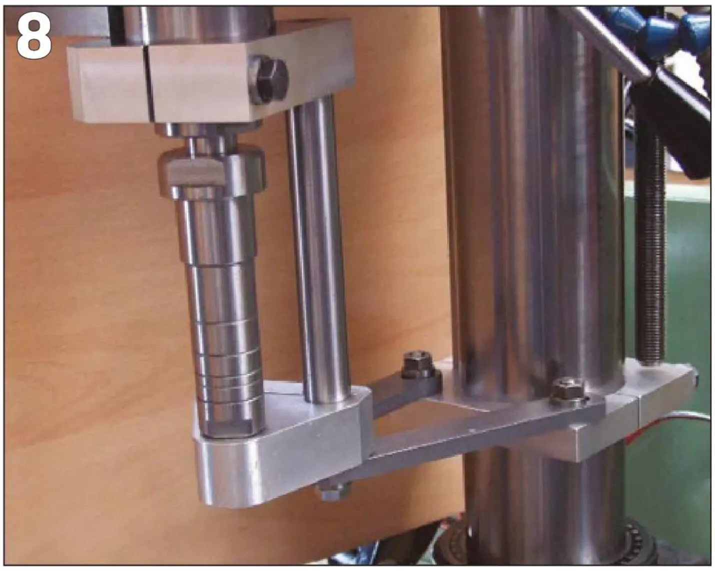
There is no reason why all of the studs cannot be set bolts, but I think that the studs save an awful lot of wear and tear on the aluminium tapped holes. It is far easier to replace a standard M8 steel hexagon nut than to reclaim a damaged thread.

I did find that it was an advantage to use M8 bolts by 25mm long in the ends of the overarm support bars when attaching the tie-bars as this made for an easier assembly – especially when the overarm bearing support is in close proximity to the milling machine table, plus these bolts are going into steel tapped holes.

I have shown on the drawing thick washers for use with the hexagon nuts or set bolts, this is one of my standard washers used on all my clamping arrangements. The reader can choose a standard plain washer but these do not in my opinion afford much support and usually lead to distortion of the clamping face. Given a lot of use such washers can become 'dished', especially when used on aluminium.

It takes very little time to run off several dozen washers as the outside diameter is not machined. They can of course benefit from some treatment to the outside diameter with some emery cloth beforehand, especially if there is some surface rust present.

The hole is merely drilled to a sufficient depth to allow a batch of washers to be parted off, but I would not advise drilling this hole all in one go. During the parting-off operation a fine file, with handle, is presented at an approximate 45-degree angle to the rotating embryo washer on both edges to remove the sharp edges thrown up during the parting-off operation. The reader can use a 45-degree chamfering tool for this operation and can make one chamfer larger than the other. For my purposes I settle for the simpler version as it does not matter then which way up the washer goes.



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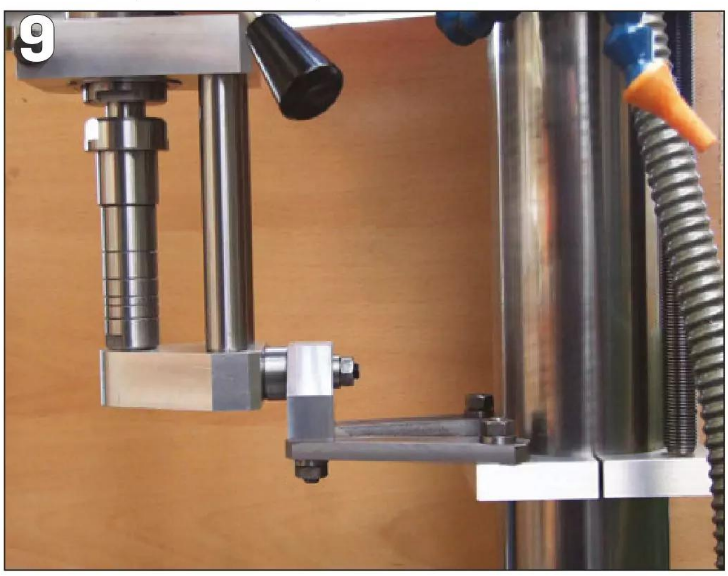
"This addition has paid for itself many times over and has permitted me to do some tasks which I would have otherwise fought shy of..."

Having had a chance to use both set-ups extensively there is very little to choose between either as regards their rigidity and it is merely down to the end user which design is plumped for. The fitting of this additional support made the cutting of the second larger gear for my friend's stationary engine a good deal easier and the work was carried out in just two passes with a big improvement in the machined finish – this job alone more than paid for the construction of the additional support attachment.

The attachment has since been in almost constant use on other projects, one job in particular involving some quite heavy milling with a pair of 6mm wide side and face cutters. This was something I would not have considered doing with the normal FB2 set-up, or with the original basic overarm support, but with the combined set-up this too was carried out effortlessly. Thus this addition has paid for itself many times over in the short period since it was constructed and has permitted me to do some tasks which I would have otherwise fought shy of. EIM

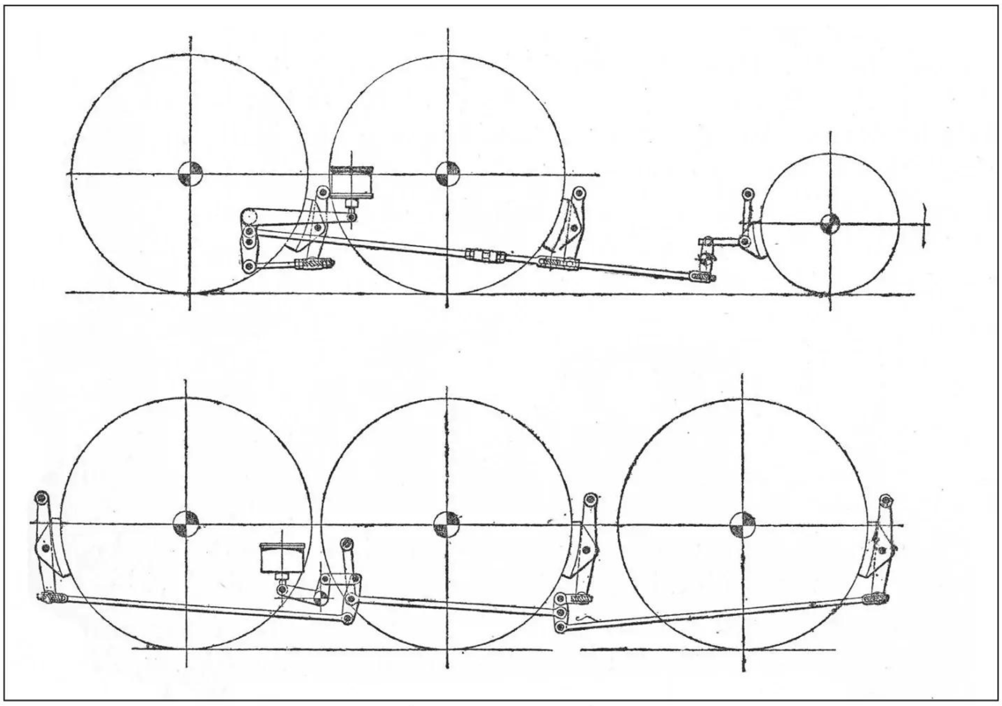


9

The art of stopping

Our series uncovering the mysteries of the steam locomotive, for those who don't know how everything works, focuses on the vital area of brakes...

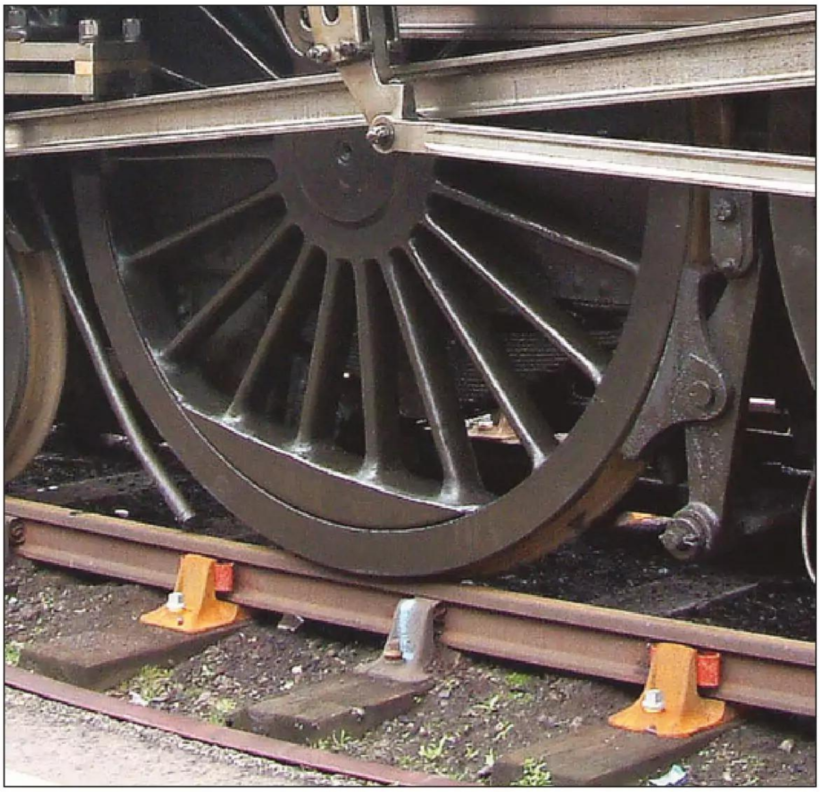
BY **ANDREW CHARMAN**



It is all very well being able to make a steam locomotive move away from rest and accelerate along a track – being able to slow it again and bring it safely to a stand is of course just as vital, especially if we are talking full-size standard-gauge steam with a train of perhaps more than 200 tonnes or more trying to push said engine down a hill. In fact British Railways 9F Standard 2-10-0s are said to have hauled freight trains of 10000 tonnes...

Over two centuries of steam locomotive development various methods of arresting motion were developed, but through it all the brakes themselves remained delightfully basic and simple – they are nothing more than large blocks, usually made from cast iron and shaped to match the outside diameter of the driving wheel. All the blocks are interlinked to each other and when the brake linkage is operated all the blocks come into contact with the tread of the wheel, the resultant friction slowing and eventually stopping the locomotive.

The simplest way to operate the linkage is by using the handbrake. This is a handle or a wheel located on the footplate in the cab, and it operates a screw which is connected to the brake linkage running to the coupled wheels. Turing it clockwise pulls on the brakes, turning it anti-clockwise takes them off – the old adage of "Righty-tighty, lefty loosey... The handbrake functions in similar fashion to the parking brake on a car – it is only generally used to secure the loco from running away when it is stationary.



ABOVE: Brakes on a steam locomotive, and the linkage that applies them.

LEFT: The brake block can clearly be seen acting on the driving wheel of this Gresley A4 loco at rest.

TOP RIGHT: Diagram of the driver's vacuum brake control in the cab.

TOP FAR RIGHT: Vacuum brake control on a Welshpool & Llanfair Railway locomotive.

RIGHT: This former Great Eastern Railway loco has a Westinghouse brake cylinder fitted to the side of its smokebox.

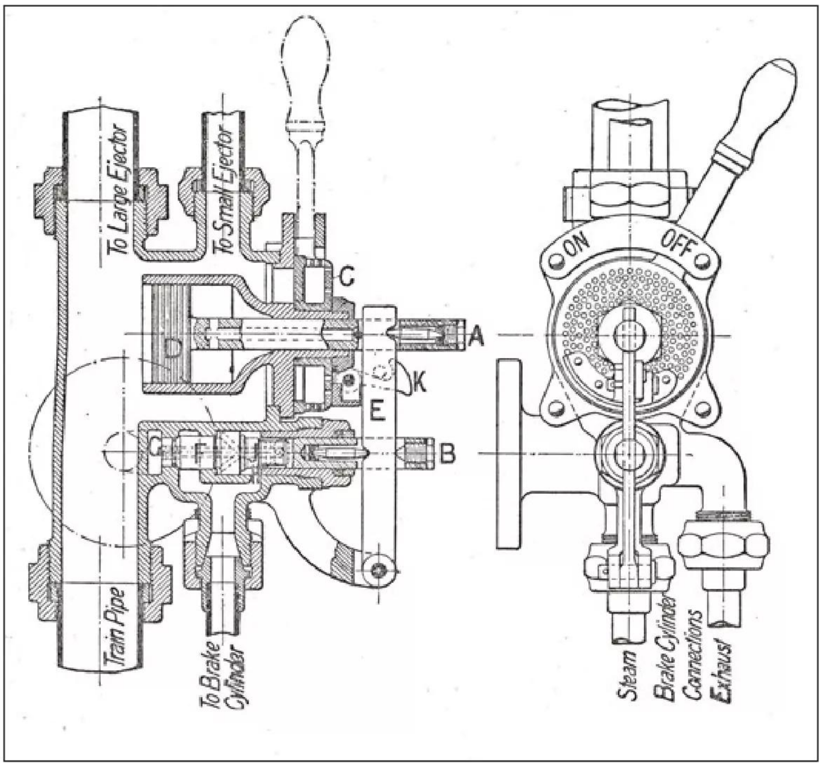
The majority of locomotives are fitted with a steam brake. The driver operating a lever in the cab results in steam taken from the boiler being admitted into a cylinder, and this forces a piston along the cylinder to operate the linkage that runs to the brake blocks.

Air or no air

Locomotives can also be fitted with vacuum or air brakes, and these form the two major methods of braking a train, as opposed to the locomotive on its own. In fact it was following a fatal railway accident at Abbots Ripton that led to an Act of Parliament of 1889 mandating that all passenger trains must have continuous brakes acting on every wheel of the train.

This rule does not apply to freight trains – they can instead use mechanical brakes working independently on each wagon and operated by a lever on said wagon, the lever secured with a pin placed through a hole – this is known as 'unfitted' stock.

Before descending a steep gradient, such trains must stop while a member of the crew – often the guard – 'pins down the brakes' by pushing



down the levers, pushing the brakes partly on and securing them in this state so that the wheels drag on the hill allowing far easier braking control from the locomotive.

It is important not to pin the brakes on too hard as this will lead to locked wheels and flat spots worn on their tyres – an expensive problem that can also be caused by too aggressive braking on a locomotive locking its wheels.

Piped together

In a vacuum-brake set-up all the vehicles of the train (including the locomotive) are joined by flexible pipes. Each vehicle has a cylinder mounted on it in which is created a vacuum, this maintaining the brakes in an unapplied 'off' position.

This vacuum is created by the driver operating a device known as an ejector, which pulls the air out of the system and maintains the vacuum. The ejector is controlled from the cab and can also be mounted in it, though the valve in question is often mounted on the smokebox or on the side of the loco close to the footplate.

The ejector works in a similar way to an injector for admitting water to the boiler under pressure – steam is admitted into it and through a cone where it is combined with the air in the brake pipes. The cone forces the steam to increase in velocity, creating a vacuum which draws the air out of the brakes and through a pipe to the base of the chimney, where it is exhausted to the air.

When the vacuum is destroyed by letting air into the system, either by the driver operating the brake or a leak occurring – for example two vacuum pipes separating – the brakes will automatically be applied. The major advantage of this of course is that should a train become divided for any reason, the brakes will come on – a useful safety feature.

Much of the manner in which air brakes work is similar to that of vacuum brakes. Each vehicle in the train is connected by pipes but compressed air in the pipes, created by a compressor mounted on the loco, operates a cylinder on each vehicle and this brings the brakes into use.

The air-brake concept is older than that of the vacuum brake and early versions had a major disadvantage in that if the 'circuit' was broken and the air pressure lost, the brakes would come off. American George Westinghouse, credited with inventing the air brake in 1869, developed a more effective version three years later which, by means of a triple valve set-up, uses a reduction of air pressure in the system to apply the train brakes rather than the other way round.

Westinghouse's system puts a reservoir on each vehicle in the train. If the pressure in the train pipes falls, either by the driver or guard operating the brake or a break in the pipe, the triple valve is moved into a position where air is admitted from the reservoir, pushing the pistons that operate the brake linkage and stopping the train.

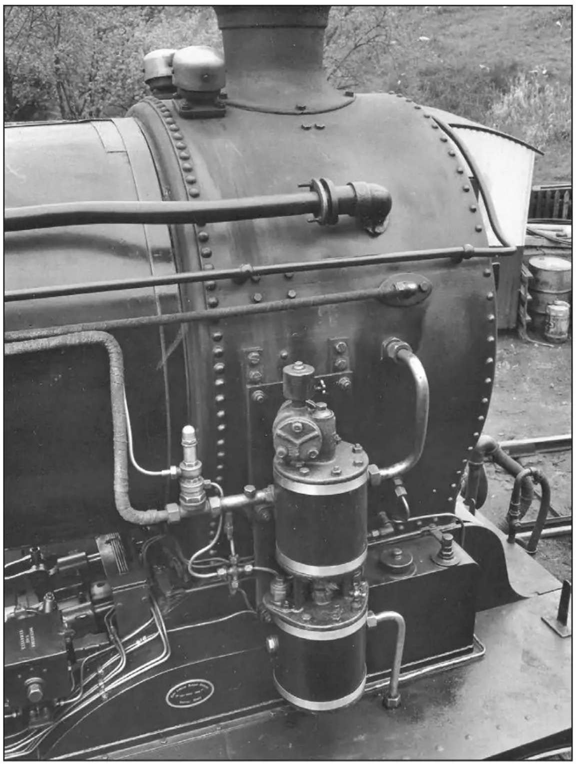
Appealing noise

The air compressor itself, comprising a pair of vertically-mounted cylinders with a piston moving between them, is usually mounted on the exterior of the locomotive – the most obvious variety fixed to the side of the smokebox. And it produces a very distinctive sound – an acquaintance of your editor absolutely loving this sort of steamy clanging noise!

"This will lead to locked wheels and flat spots worn on their tyres – an expensive problem..."

Of course in our model scales the locomotive is powerful enough to provide much of the braking effort needed to arrest progress, although some passenger-carrying miniature railways also have additional brakes on the passenger stock, operated by the guard. EIM

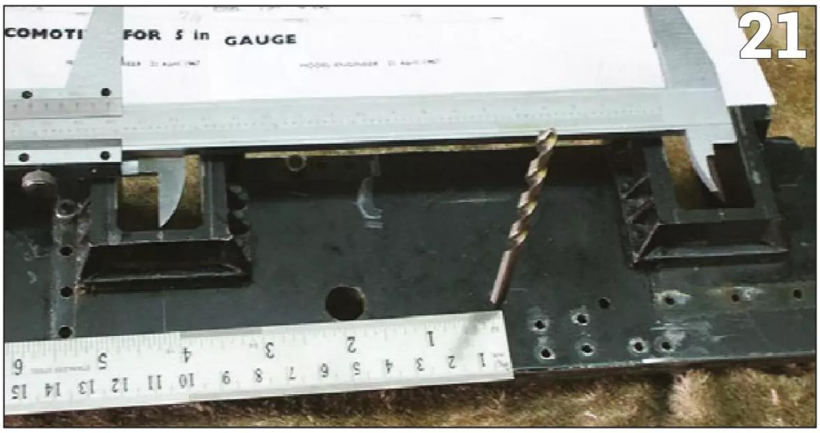
■ Next time – essential lubrication



Defeating the Gremlins

Stewart continues his tale of restoring a part-complete Martin Evans Simplex that he bought on a whim and then left alone for several years before discovering the horrors it held...

BY **STEWART HART** Part two of three



Having carried out the extensive restoration work on the cylinders of the Simplex described last month, I turned to the loco's frame and hornblocks.

When I got things stripped down to the frame, I was faced with a sorry sight – the hornblocks looked as though they had been roughly filed out with no attempt to get them square and to achieve a decent fit of the axleboxes. From reading the books of LBSC I know it is possible if care is taken to file out the horn blocks, but this certainly wasn't the case here.

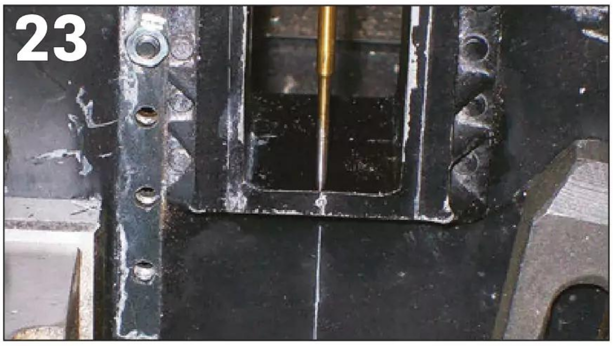
I first checked the frame to see if it was square – this was simply done by measuring across the diagonals of common points. The measurements should be the same but from memory I found that the frame was out by about 6mm. A good square frame is a critically important functional feature, as its forms the backbone of the engine for mounting and correctly aligning the cylinders and the motion works. Fortunately the frame had been bolted together so I had a chance to correct these errors.

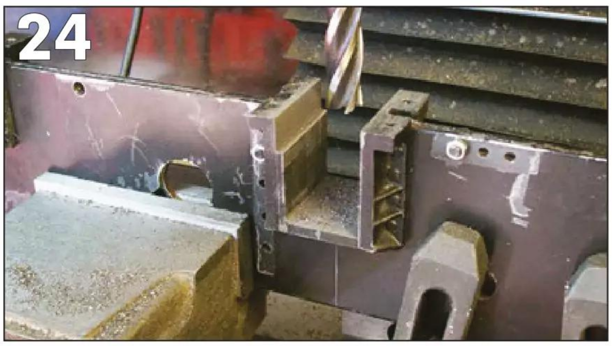
The buffer beams and stretchers were unbolted and the two halves of the frame were placed back-to-back. Lining the two sides up by passing a drill through the drawing's datum hole, the two frames were checked against each other. Everything lined up except for the hornblocks, but these were going to be reworked anyway. I then checked the faces of the stretchers to see if they were square and found that they were out by miles, which explains why the frame assembly was out of square.

To rework the hornblocks the two halves of the frame were bolted together back-to-back using a couple of the existing holes, again making sure that the datum hole lined up. From this datum hole the centre of the hornblocks were marked out to their correct drawing position (Photo 21).

The table on my milling machine was too short to allow me to machine all three hornblocks in one setting, I would have to mill two of the sets then reposition the frame to mill the third. The frames were set up level and square in the milling machine using a vice and an angle plate – two vices or two angle plates could have been used but I only had one of each.

Using a pointer the mill was lined up on the first location and the DRO (Digital Read Out) zeroed. The cast





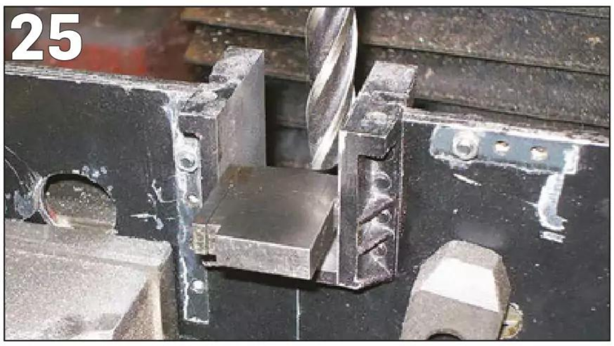


PHOTO 21: Frame marked out for centre of axlebox.

PHOTO 22: Setting up for milling out hornblocks.

PHOTO 23: Locating on hornblock position using a pointer.

PHOTO 24: Milling out hornblocks with long-series end mill.

PHOTO 25: Width checked with slip blocks.

PHOTO 26: Re-positioning to machine trailing block.

PHOTO 27: Setting frame square using machined hornblock face.

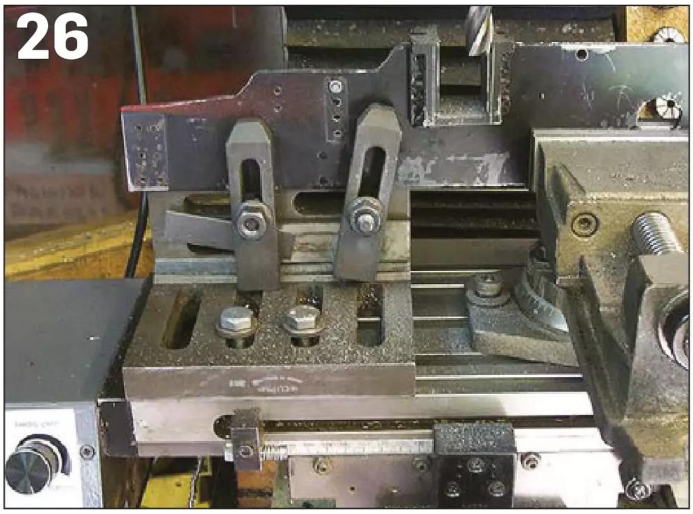
PHOTO 28: Mill set on centre using wobbler.

PHOTO 29: Checking final position – error .001-inch

PHOTO 30: Jig for milling hornblocks to width.

PHOTO 31: Blocks all milled to all the same width using jig.

All photos in this feature by the author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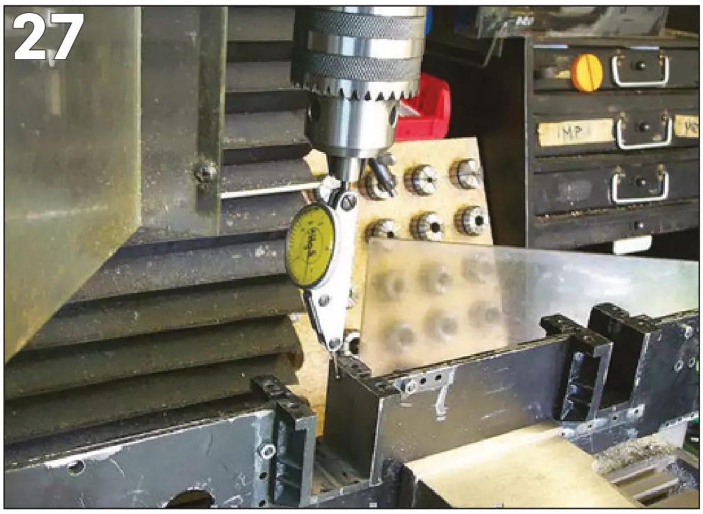
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hornblocks had just been cleaned up with the file, so they were under size allowing me to bring them to the correct drawing size with a long-series end mill, taking care to take the same amount of each side off the centre line to retain position (**Photo 22-25**).

The leading hornblocks were machined first – the angle plate was moved to the other side to give support to the middle hornblock, using the DRO with a sanity check from the pointer, the mill was centred on the middle hornblock for machining (**Photo 26**).

To machine the trailing hornblock the frame was released from the vice and repositioned. Using the now machined centre hornblock as a reference the set up was clocked square, and the centre found by using an edge finder, with a final sanity check using the pointer and marking out, before the hornblock was machined as before (**Photo 27-28**).

The frame was then removed from the mill and a check on the 7⅛-inch hornblock centres showed an overall error of 0.005-inch – close enough for this Gremlin (**Photo 29**).

The outside face of the hornblocks were all level with the frame which is correct to drawing, but their overall width, which should have been ⅞-inch, were all undersize by differing amounts. This is an important location feature for the axleboxes and the end float of the axles that has an effect on the cornering of the loco. There was nothing for it but to reduce the width on all the hornblocks to that of the narrowest block, and to increase the flange on that side off the axlebox by the same amount to compensate.

To reduce the hornblock width a location plate was milled up to a close fit on the block – each horn was clamped to this in turn and their thickness reduced so that they were all the same (**Photo 30-31**).

There was one final piece of butchery to sort out on the frames. They both had keyhole-shaped holes drilled and filed to line up with the boiler blowdown valves – neither of the valves lined up with this hole very well, and they were positioned differently on the boiler. This to me was visually offensive, so I simply bored out the frames to take a thin mild-steel plug that I had tack-welded into the frame and cleaned off the surplus weld. You can still see this plug under the paint but they look as though they belong in this form (**Photo 32-33**).

Frame stretchers

As mentioned a check to determine whether the faces of the frame stretchers were square showed they ▶

"Neither of the valves lined up with this hole very well, and they were positioned differently on the boiler – this to me was visually offensive..."


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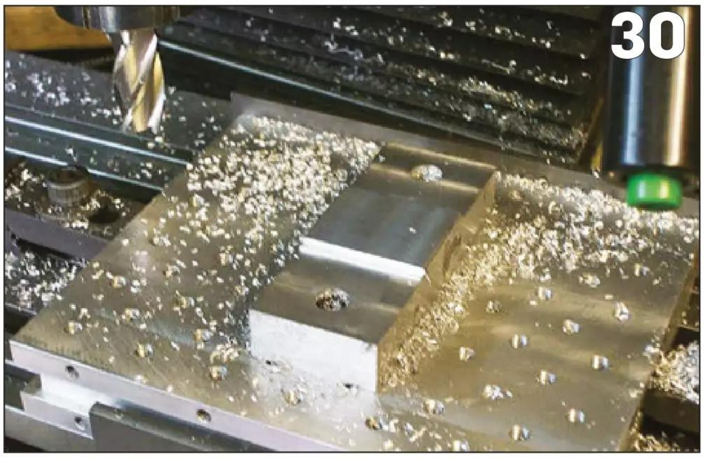
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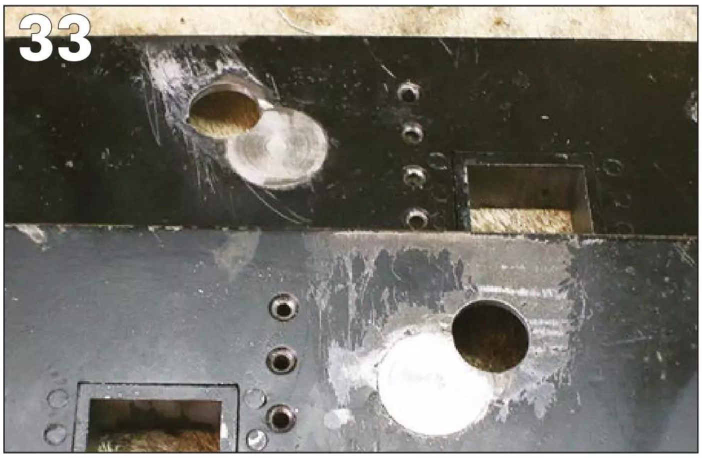
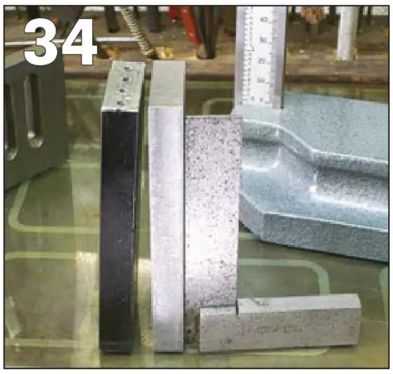
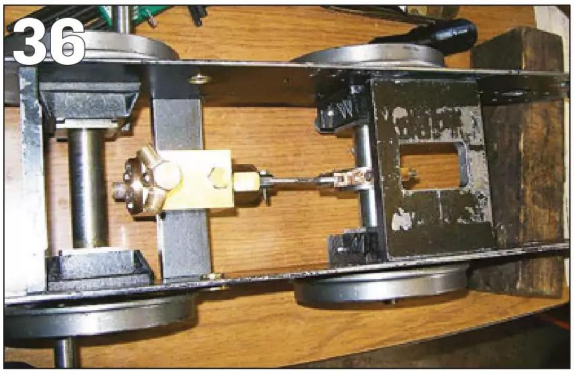






were a mile out, explaining why the frame was not square, and the only way to correct this was to make new stretchers (Photo 34). This provided me with the opportunity to modify the front frame stretcher, adding an access hole to the water-pump eccentric to facilitate oiling (Photo 35-36) – a little tip I picked up while hanging around the steaming bays of my local club.

These new stretchers were fitted to the frames and the diagonals checked, and I was delighted to say everything was nice and square. The front and rear buffer beams were then added and another check carried out, and things remained nice and square.

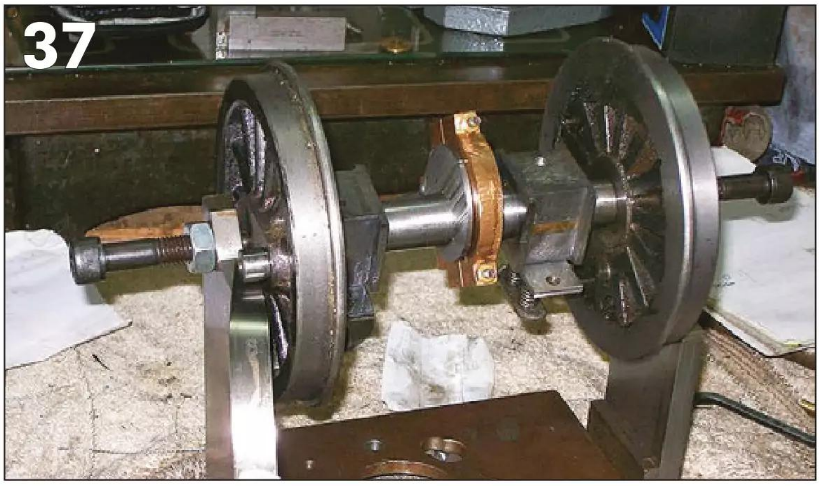


PHOTO 32: Frame horribly butchered for blowdown valves.

PHOTO 33: Frame plugged and tack welded.

PHOTO 34: Left is out-of-square stretcher, at right new square stretcher.

PHOTO 35: Recess cut in stretcher to gain access to pump eccentric for oiling purposes.

PHOTO 36: The completed stretcher and pump assembly.

PHOTO 37: A wheel set – lots of issues found here...

PHOTO 38: Homemade wheel puller made up.

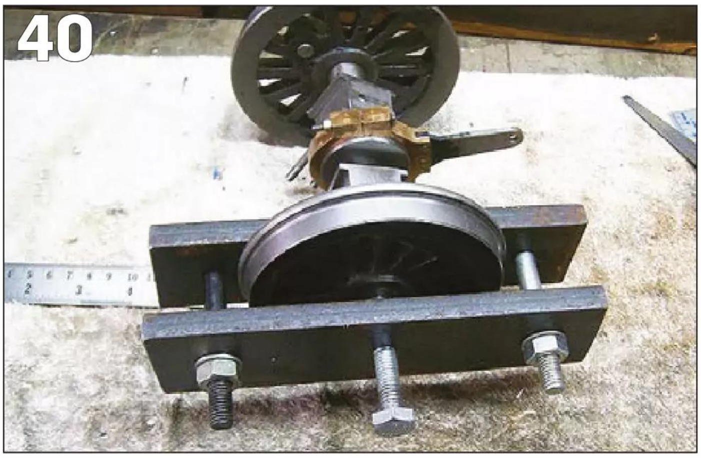
Wheels and Axleboxes

The corrective work on the frame meant that the axleboxes would be far too loose, so new boxes would have to be made and fitted. This meant that the wheels would have to be pulled off the axles, but before I did this I checked that the drive pins on the wheels were all at the same PCD (pitch circle diameter). This is another critical functional feature – the actual size within reason is not really that important as all this does is vary the stroke, but for the connecting rods to operate smoothly the PCD for each of the crank pins must all be the same.

To conduct this check I mounted each axle between the centres of a quartering jig borrowed from a club member (Photo 37) and measuring the centre height to the drive pin, to my horror I found that they varied by about 3mm.

This revelation seriously upset me, I thought I was going to have to buy a new set of wheels, so I put the project to one side and worked on a stationary engine for a few months, went on a short holiday, mulled the problem over and talked it through with some of the club members.

Picking up the challenge again, I carefully re-measured the throw of the crank pins, and realised that if I opened the hole out from $\frac{5}{16}$-inch to $\frac{3}{8}$-inch in the correct position I would just about be able to correct the throw on all the wheels to make them the



same. To do this I would have to remove the crank pins, reposition the holes and make and fit new oversize crank pins.

Drawing the wheels off the axles and removing the crank pins would risk cracking the cast wheel if it was not done correctly. The first thing that I needed was a hub puller. I made this up from some ⅜-inch thick black mild steel bar and some M8 bolts (Photo 38).

The wheels had been fixed on the axles with Loctite but one wheel on each axle had also been keyed to the axle with a round pin (Photo 39). Tackling the unpinned wheel on each axle first, the hub puller was slipped behind the wheel, checking that it was supporting it as much as possible, then the pull bolt was located in the centred axle and slowly tightened up to put the joint in tension.

Heat was gently applied using a hot-air paint stripper blow gun to soften the Loctite – you need to wear heavy leather gloves as things start to get a bit hot. With the increasing heat you slowly tighten up the bolt, but don't be tempted to rush things, let the strain and heat build up slowly, then with a bit of luck the adhesive bond gives way and the wheel pops off. This can happen quite suddenly and take you by surprise (Photo 40-41).

The pin was drilled out of the remaining wheel (Photo 42), before repeating the procedure and pulling it off also.

To remove the crank pins a new flat-ended draw bolt was fitted to the puller, but this time it would be used to press the pins out of the wheels from the back. I followed a similar procedure to the axle, applying heat from the blow gun and gradually building up the pressure on the pin until it was pressed from the wheel.

To recut the crank-pin hole in all of the wheels in the same position you need to make a simple jig, this consists of a chunk of aluminium with a mandrel screwed in that's a close fit on the wheels with an M10 nut and washer (Photo 43).

To use this jig simply centre and zero the mill on the mandrel, move the mill $1\frac{1}{16}$-inch, being the correct crank throw and lock the mill table up tight (X and Y). In this case as I was correcting existing holes I used a ⅜-inch end mill that would ignore the existing hole and cut in the true position without disturbing the mill, each wheel was corrected in turn (Photo 44).

As a sanity check that all the wheels were the same, a simple check was carried out by passing a length of ⅜-inch silver steel through all the crankpins at the same time and checking that the axle holes all lined up (Photo 45). Now what could be simpler than that, why it wasn't done correct in the first place is beyond me.

Pulling the wheels off the axles revealed more mischief – the journals had obviously been turned under size ▶

PHOTO 39: Left-hand wheel pinned to axle.

PHOTO 40: The wheel puller in action.

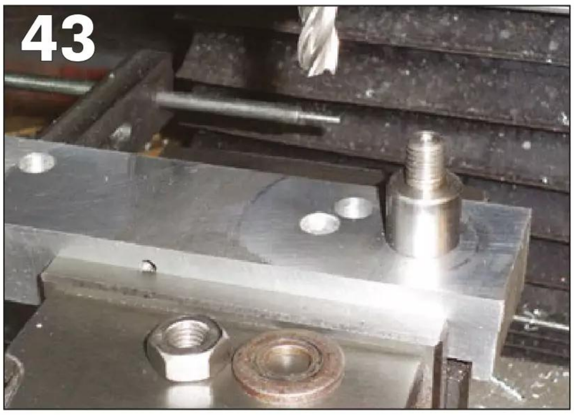
PHOTO 41: The wheels once pulled off their axles.

PHOTO 42: Drilling out pin before repeating pulling action.

PHOTO 43: Fixture for correcting wheel crank throw.

PHOTO 44: Correcting wheel crank throw using end mill.

PHOTO 45: Silver steel rod passed through crank pin holes confirms all now line up.



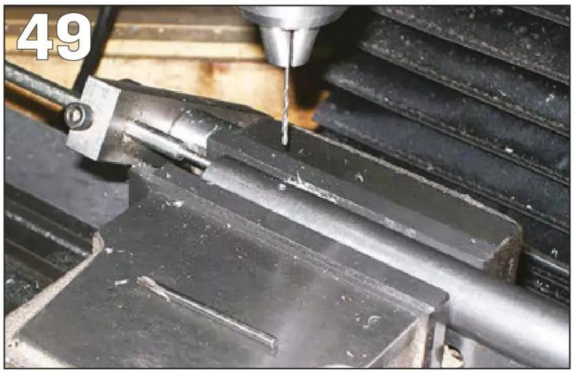


PHOTO 46: Centre-punch holes show where axles were bodged to fit.

PHOTO 47: Turning new axles between centres on the lathe.

PHOTO 48: Axles and wheels paired up ready for quartering.

PHOTO 49: Drilling oil way in axle.

PHOTO 50: Wheel and axle paired off, note the oil way in the axle.

PHOTO 51: Set of newly-made axleboxes.

PHOTO 52: Axle assembly on the quartering jig.

PHOTO 53: Wheels and axles assembled in the frame.

PHOTO 54: A present before matters get too weighty, a hydraulic lift table.

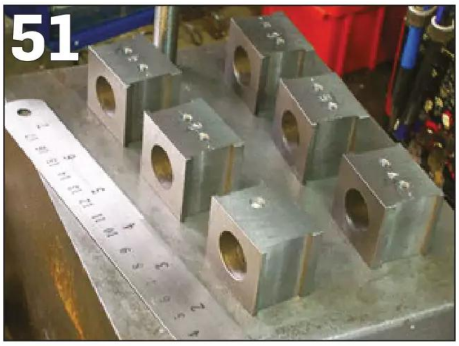
and corrected by a ring of centre pop marks (Photo 46). There was nothing for it but to make new axles to a correct fit on the wheels. Each wheel had to be measured, numbered and the axle made to the correct fit and also numbered (Photo 47-48).

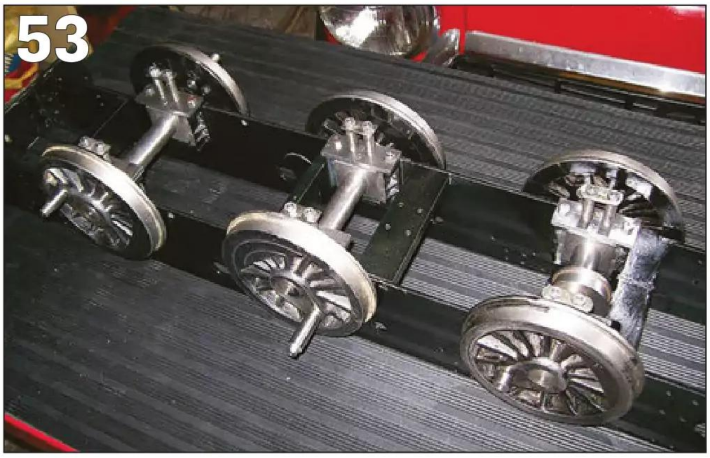
The axles are lubricated via holes in the axleboxes that are not very accessible. Other builders have added oil boxes with oil pipes leading to these oil ways but I preferred a more direct solution. I drilled an oil way through the centre of the axle and then drilled a cross hole to meet it (Photo 49-50). As a result I can now oil the axles quite easily.

All that remained was to remake and fit the new drive pins to match the wheel, make and fit new axleboxes and to fit and quarter the wheels on the axles – all covered off many times in the Simplex build book by Martin Evans (Photo 51-53).

With this success I decided to give myself a little treat in the form of a hydraulic lifting table – this would make things easier when assembling the loco especially with the aid of a rotating assembly frame, and would be essential for loading the completed loco into my estate car for taking to the track (Photo 54). EIM

■ Next month Stewart tackles the motion and other components. To download a digital back issues or order a printed version of part one of this series published last month, go to www.world-of-railways.co.uk/store/back-issues/engineering-in-miniature or order by phone on 01778 392484.





Making automatic drain cocks

Stewart Hart's account of rebuilding a part-built Simplex (EIM, *last month and this*) recalled similar struggles to fix secondhand engines, luckily not personally, but by friends and in clubs. This is not to say I have not done a spot of rectifying parts of engines but as they were 'home-made' I knew where to lay the blame!

The reference to automatic drain cocks (valves) is interesting as I have recently made six of a suitable size for a 3½-inch gauge engine. Although good cocks are commercially available I did not fancy my chances of rigging up the operating linkage to the inside cylinder of a Royal Scot situated just above the front of the bogie.

A design for a big automatic drain valve that had appeared in an American magazine years ago came to mind and I remembered having sketched it out and filed it away. In the same way that odd ends of metal go into my scrap bin(s) I keep an Odds File with useful sketches and incredibly, there it was, already redrawn suitable for 1⁄16 scale.

I needed to know if it worked so I quickly knocked up a prototype using brass rod (from the brass scrap bin). The working dimensions are ball diameter = ⅔ chamber diameter and discharge hole (ball seat) ≈ ¾ ball diameter

The principle of operation lies in the very big difference between the properties of water when in its liquid phase and when a saturated vapour (wet steam). The steam that enters the horizontal chamber via the connection to the cylinder has a low density and it can turn a tight corner, so to speak, and make a bee line towards the exit thereby entraining the ball that seals off the discharge.

Water on the other hand, being a relatively dense liquid, produces turbulence on its way out and the ball is unable to seat.

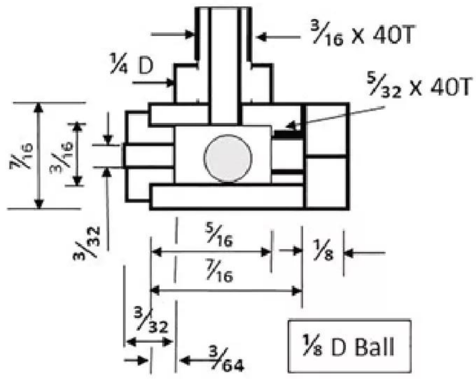
The only critical operation in manufacture is the same as that for other valves closed by balls: to seat a spherical (?) ball truly the hole must be perpendicular to the seat surface (drill in lathe) and be truly circular (finish with reamer or d-bit).

Practical test

Not having an engine in steam I brought out my test kit, the usual bit of rubber tube and my mouth, plus a glass of water. With the valve held horizontal blowing produced a nice click as the ball seated without passing air (no bubbles under water), then after sucking up half a tube of water another blow expelled it until 'click' the ball shut. I repeated this many times, more from fascination rather than doubting its operation.

I made another basic inverted T-shape valve for the middle cylinder then four more for outside to the same working dimensions but 'dressed up' to look like the Midland Railway compression relief valves. Now I just need to finish the engine to see them in action...

Mike Wheelwright



DRAWING APPROX TWICE FULL-SIZE

Power for the plater...

Would you please ask Rich Wightman where he got the power supply that he used in his recent articles on plating and etching in the workshop? (EIM, August to November 2020). I ask because I am going to try out some nickel plating on some parts of a model steam engine that I am building and maybe etch some nameplates as well.

Robert Knox

Rich Wightman *replies:* I like to experiment with things around the workshop, some of them electrical. To do so I prefer to play with 12 volts, a little safer than 240-volt and with only two wires to worry about being DC.

I have a couple of 12 volt transformer/power supplies in the workshop, a quick search on ebay and I found the one illustrated here, which is similar to the ones I use and reasonably priced at £13.70. A further search may find them on sale cheaper.

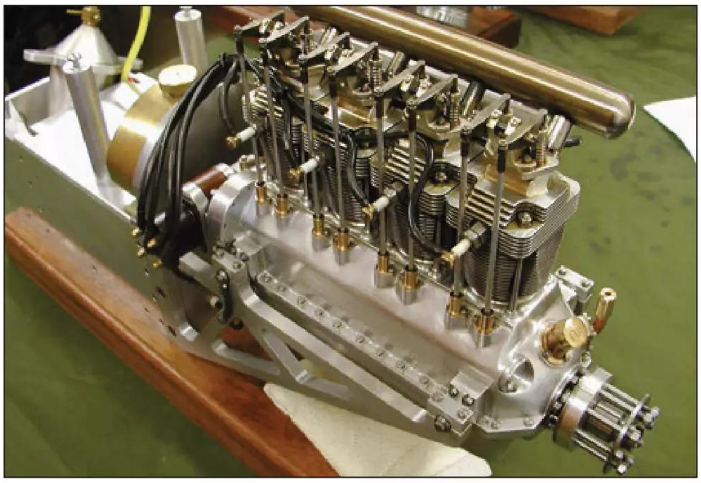
An adjustable 12-volt regulator similar to the photo at right and priced at £3.39 is plugged into the 12-volt power supply. I mounted the regulator in a plastic box complete with attachments for the crocodile leads I used. I hope that answers Mr Knox's question.

Battery loco wiring

The Editor writes: We've received a few letters in response to Peter Kenington's current series on electric motors and their wiring for battery locos, some offering comments while others have asked for further information on the subject. We've agreed with Peter that the best way to answer these will be in one go at the conclusion of the series. So watch this space!

Model engineering subject to raise? Burning question requiring an answer? Pertinent point to make? Send your letters to the editor at 12 Maes Gwyn, Llanfair Caereinion, Powys, SY21 0BD or by email to andrew.charman@warnersgroup.co.uk Illustrations welcome but by no means mandatory!

Tom Pasco – his life with IC engines



Following a brief illness, Tom Pasco died in hospital on the 12th October. His internal combustion engines will be familiar to anyone who visited any of the model exhibitions at Harrogate, Doncaster and the Midlands over the last two decades. All were superbly built and regular winners of medals and trophies.

Tom was born in Wilton near Redcar and spent his early years on the family farm at Thorpe Thewles near Stockton on Tees. It was here that his love of machines began and he acquired his first lathe. He joined the Thornaby Pathfinders model flying club and, with his friends Keith Dale and Wesley 'Bill' Haley, formed a control-line racing team.

Tom, of course, was the 'engine' man. His home-modified ETA 29 and McCoy glow-plug engines won the team nationwide success, their photo featuring in the E.T.A. company's regular advertising in *Aeromodeller* magazine. At this time he was an apprentice toolmaker at Metro Vickers in Stockton-on-Tees.

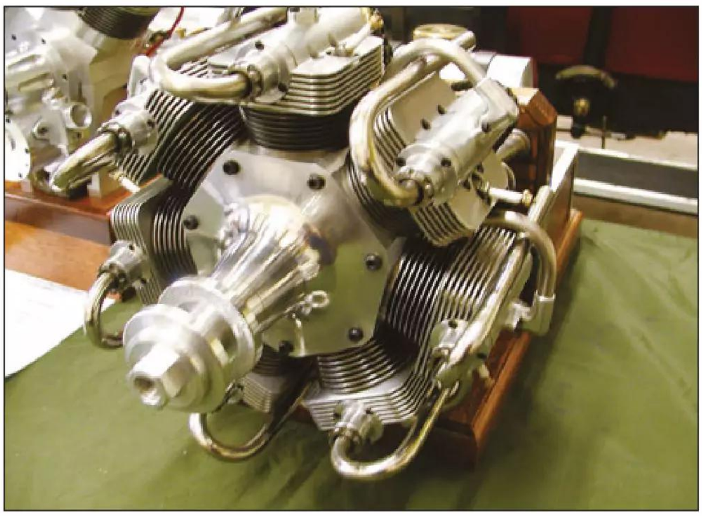
Racing to success

Transport to and from the team racing contests was always by motorbike; eventually leading Tom to modify one for local club racing, initially using a BSA Goldstar engined Norton, ridden by his friend 'Bill' Haley. Tom soon teamed up with another lifetime friend, Russell Armstrong, to build a bike to challenge the domination of the Manx Norton in club racing circles.

Acquiring a 650cc Triumph Twin engine, Tom converted this using a short-throw crank to suit the 500cc class and designed a twin overhead camshaft cylinder head. This remarkable conversion was home built by Tom, who carried out all the machining on his Myford lathe in his home workshop.

This engine, when fitted to a home-built frame and ridden by local rider, Tommy Armstrong (no relation to Tom's friend), proved a success racing at Croft Autodrome and achieved the aim of beating the Manx Nortons in private hands. Tom went on to become nationally known as an engine tuner, after the end of 1974 adapting to the now more competitive Japanese two-stroke units – 250 & 350 Pasco-tuned Yamaha two strokes were used with great success; culminating in their rider, Alan Stuart, winning the British Championship in 1981. According to his son Brian Tom received several offers from works racing teams to join their squads which, as he now had a wife and family, he chose to decline.

An opportunity of a partnership in a toolmaking business was accepted and Steelnorth Tooling became a very successful business, Tom making injection mould tools for the pharmaceutical and cosmetic industries until his retirement.



An engine a year

On retirement Tom divided his time between building his famed I/C engines and long-distance walking. His output of I/C engines was enviable. One per year was his aim, beginning with a model of the four-cylinder 'Gale' two-stroke unit, a much publicised effort in around 1960, to build a four-cylinder 50cc racing unit that used a form of cycloidal crank mechanism to provide straight-line motion to opposing cylinders to reduce piston wall friction. Tom knew the inventor, Norman Gale, well and it is possible (though cannot now be confirmed) that Tom made the original test engine. His model made in 2001/2 was exhibited at the Midlands Exhibition in 2002.

Of the 16 engines Tom built only one was a true scale model, his beautiful ¼-scale Gypsy. He followed existing commercial drawings for this but machined everything from solid. All his other engines were his own original designs and utilised every possible configuration. Each had a design element that intrigued him and that he wanted to demonstrate using rotary, sleeve and poppet valves, supercharged, both two-stroke and four-stroke, single to seven cylinders and everything inbetween.

To say that Tom's engines were often unusual is, perhaps, understating the case. Many could be hardly understood by the casual observer but they all ran beautifully.

Of all his unusual engines, perhaps the most thought-provoking is his two cylinder Demont unit. This was built to demonstrate the configuration of the original Demont six-cylinder rotary of 1916. Whether this was ever built and fitted to an aircraft is unknown but the engine fired above and below the piston, double acting as in a steam engine. The piston is annular and surrounds a hollow trunk guide that moves with the piston, the con-rod being inside it.

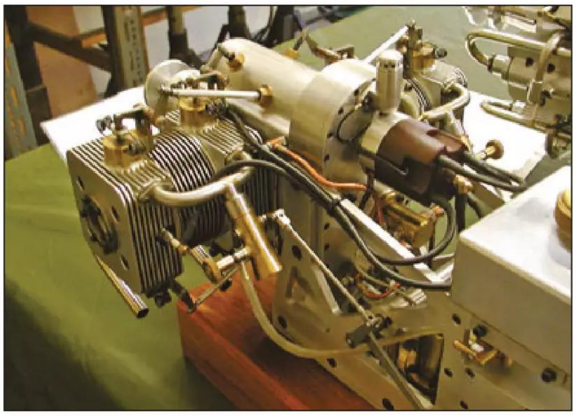
To cool the piston, which receives heat from combustion taking

TOP LEFT: The twin overhead camshaft cylinder head made by Tom Pasco in 1966.

TOP: A ¼-scale D.H. Gypsy aero engine.

LEFT: A seven-cylinder radial engine using chain-driven Cross-type rotary valves.

ABOVE AND BELOW: Front and rear views of the twin-cylinder Demont double-acting engine.



place above and below it, air is pumped from the crankcase, up the trunk guide, through cooling ducts in the annular piston and then to atmosphere. As can be imagined, the combustion chamber shape is extremely complex. That this two-cylinder engine runs so well is a testament to the ingenuity and design capability of Tom.

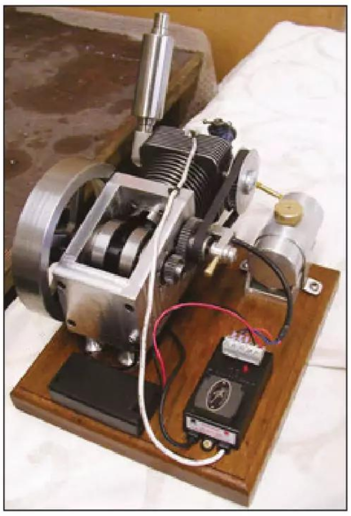
To list the number of Gold and Silver Medals and trophies that Tom acquired is unnecessary but there was never a more worthy winner of the Edgar Westbury trophy. His understanding of all forms of the internal combustion engine and his ability to transform this understanding into working prototypes was incredible.

His penultimate engine, a four-cylinder supercharged, two-stroke engine with poppet valve exhaust has never before been exhibited, but this will be entered in the next Doncaster and Midland Exhibitions, whenever they may be.

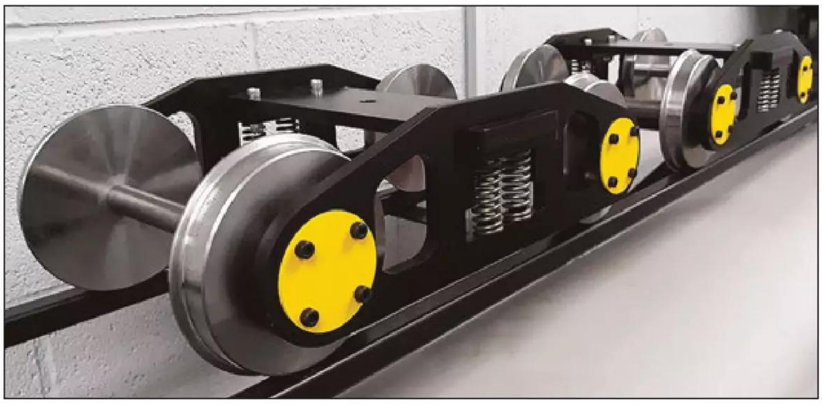
Tom's final legacy will be the single cylinder horizontal engine with rotary valve induction and exhaust designed for the Minimag Company. This will be marketed as a set of drawings with suitable ignition equipment in due course.

Tom leaves his partner, Carol, son Brian and daughter Lisa, to whom all friends offer their sympathy.

Mike Sayers



RIGHT: The single-cylinder rotary valve engine designed for Minimag.



$7\frac{1}{4}$ bogie kit from 17D

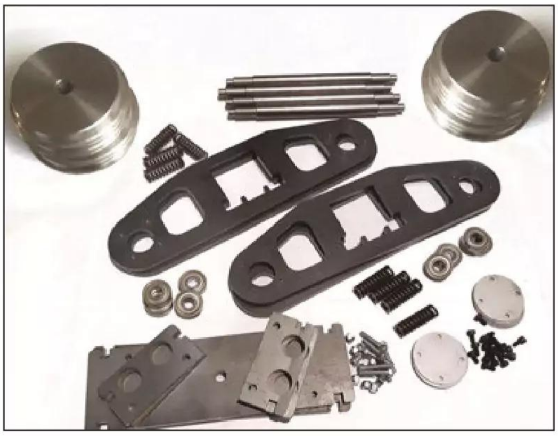
New from miniature railway supplier 17D Ltd is this $7\frac{1}{4}$-inch gauge General Purpose Bogie kit.

Nicknamed the SE700, SE standing for 'Simple & Effective', 17D describes this as the new big brother of the firm's highly successful and popular SE500 bogie kits which have been widely used on 5-inch gauge lines for several years.

Designed to be robust yet simple and straightforward to assemble, the bogies include 10mm laser-cut frames, ball-race bearings and $4\frac{5}{8}$-inch diameter CNC-machined wheels made from EN8 steel. Machined to the $7\frac{1}{4}$-inch Gauge Society standard tread profile, the wheels are $\frac{13}{16}$-inch thick and come complete with all nuts and bolts, four heavy duty springs per bogie and nylon riser blocks/load bearings.

17D intends to offer a disc-braked version of the bogie shortly.

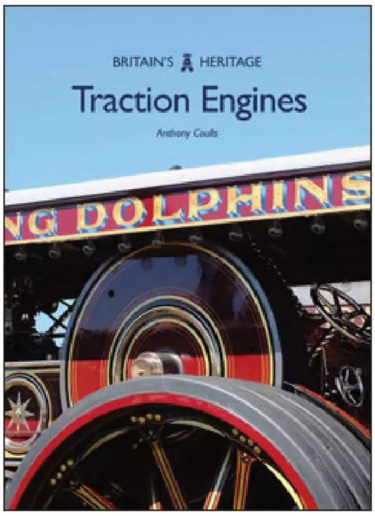
Produced by 17D Ltd
Web: www.17d-ltd.co.uk
Phone: 01629 825070 or 07780 956423

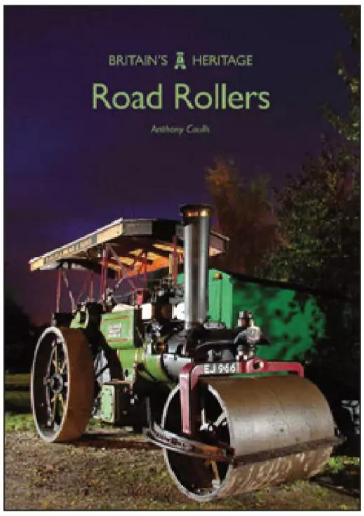


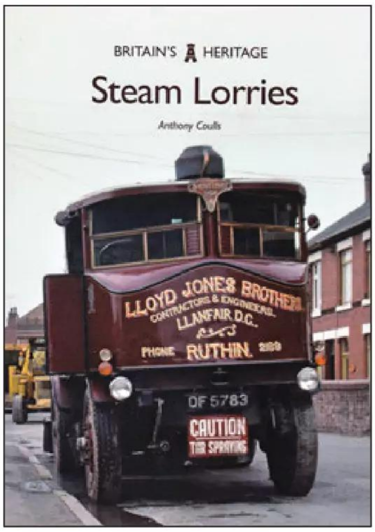
New from Barrett Steam Models, builders of Gauge 1 locomotive models featured in the May 2020 issue of EIM, are these 10mm scale waterslide transfers for models of Somerset & Dorset Joint Railway stock – they are appropriate to new black locos painted by the S&DJR from 1914 and all locos painted or repainted after 1923.

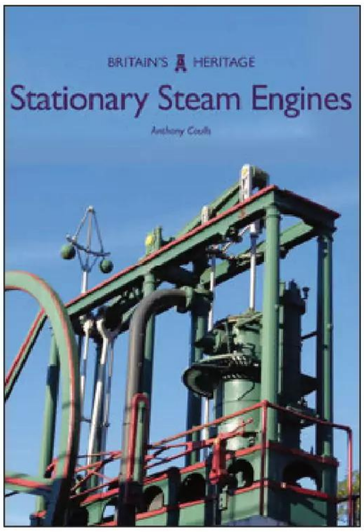
The set includes yellow-faced, red-shaded letters and numerals for tenders, cab and tank sides, along with blue-shaded bufferbeam letters. Main letters are 8mm high, with bufferbeam & numerals at 5mm and the transfers could find a use in other applications.

The full loco set of transfers is priced at £22:50 – for more details contact Barrett at www.barrettsteammodels.co.uk or on 01922 685889.









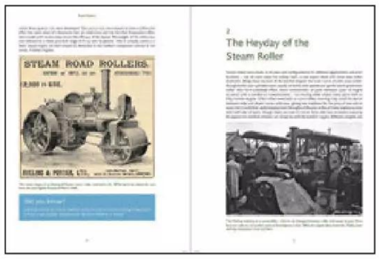
Britain's Heritage series

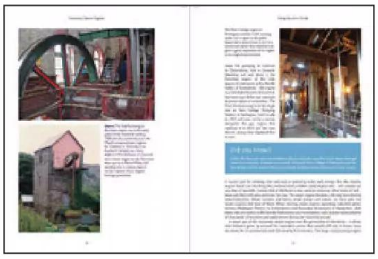
By **Anthony Coulls**

Most readers will obtain this edition of EIM before Christmas and if you are looking for a last-minute inexpensive present for the model engineer in your household, especially novices, then these slim but detailed volumes could fit the bill.

Produced by Anthony Coulls, known for his work at the National Railway Museum but also an enthusiast and advocate of road steam, the four titles provide an excellent overview of their subjects. Each softback runs to around 64 pages and tells the story of its title in a highly readable manner while imparting lots of information. Notable are the 'Did You Know' boxes, each containing an interesting fact, some of which may surprise.

Pictorial content is excellent, with plenty of shots of both period scenes and modern preserved examples of the machines described. And while in such slim volumes the author cannot go into too much in-depth detail, he does provide an excellent introduction to the subject in volumes that especially at the price are well worth adding to one's bookshelf. *AC*





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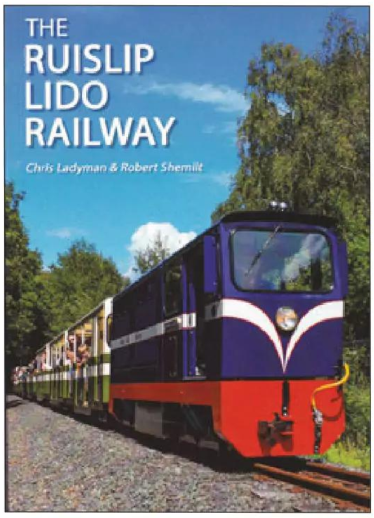
The Ruislip Lido Railway

By **Chris Ladyman** and **Robert Shemilt**



The 12-inch gauge Ruislip Lido Railway has marked its 75th anniversary in 2020, and thus this surprisingly thick and detailed volume has been published by the Ruislip Lido Railway Society. While compact in its dimensions, the A5 softback runs to just short of 300 pages to provide what is a definitive history of a line that based in northwest Greater London, is perhaps not as widely known as it could be.

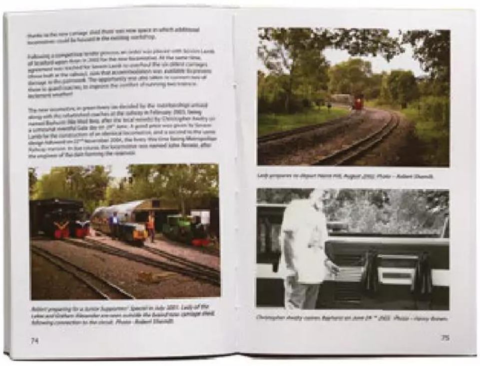
The line was established in 1945 following the development in the 1930s of the Lido from what was originally built as a reservoir in the early 1800s. Train services were operated by the local council that owned the Lido, until in 1978 an accident brought trains to an immediate halt and the local authority sought to divest itself of the railway. Only the formation of the Society saved the line from being taken up, and it has been operated by members ever since.

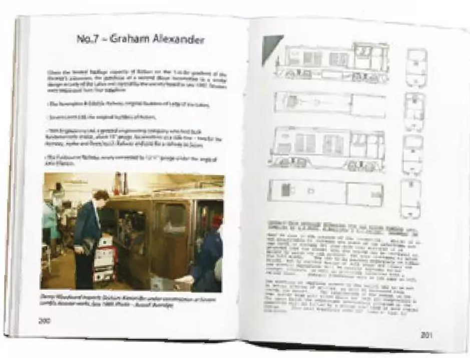
As mentioned the authors have certainly done their research to present a very full account, but for your editor one of the most interesting aspects of this story are a host of personal recollections from Society members that were there in the formative years of the modern era post 1978.

A detailed description of the route is included, while each locomotive on the roster is given its own section, including those that have moved on from the line – the current line-up includes one Ffestiniog/Penrhyn Hunslet-style steam loco and a quintet of diesels. General arrangement drawings of these and the passenger rolling stock are included in the book but these are reproduced rather small.

A major plus is the pictorial content which is prolific and includes a host of period shots. Anyone with an interest in miniature railways will enjoy this book and perhaps be tempted to visit the RLR in 2021, when the line hopes to have a delayed 75th anniversary celebration. *AC*

Published by Ruislip Lido Railway Society Ltd, available from line's ticket office on running days
Web: www.ruisliplidorailway.org Price £14.99
ISBN: 978-1-8380654-0-9





Looking forward to a new year

Lots to be optimistic about in the latest round-up from around the clubs...

COMPILED BY **ANDREW CHARMAN**

Here we go again – any thoughts of the model engineering club scene returning to some form of normality along with the rest of the world seem to have been dashed in the UK at least by more lockdowns and more complicated tiers. All of which impacts heavily on club activity, not just for the public but for members too – and all in time to ensure many clubs won't be able to run their Santa trains, when the revenue such services bring in would be all the more welcome after such a challenging year. Hey ho...

Still, we're heading into 2021 with some hopes that things are going to get better, and the mood I get from the ever-rich selection of club newsletters and journals received at EIM Towers is that model engineers at least are determined to get on with it in the hope of a more enjoyable 2021 – so let's reflect that attitude in these pages and try and focus on some of the good stuff!

And for a positive start one doesn't need to look much further than *Turnout*, the journal of the Ground Level 5" Gauge Association, and a magazine your editor is not overly familiar with. The latest edition is the 75th, which is reason to feel celebratory in itself, and certainly grabs the attention with its full-page picture on the back cover. Taken by Alan Whitehouse and kindly reproduced at the top of this page, the superb aerial drone shot of mainly freight stock taken at the Association's gathering at Saracens Head in Lincolnshire back in July 2017 demonstrates very firmly the delights of the hobby, which hopefully we will all be getting back to in 2021.

Sadly *Turnout* does report the passing of an extensive garden line, The Great Wealden Railway which closed in June of 2020, due to the increasing health concerns of its owners – the march of time none of us can escape from. But the Association certainly ensured this GWR will be remembered with an extensive report on the final running day at what was an extensive railway.

Family hobby

Elsewhere in the GL5 journal among various features showing that association members are getting on and building things, the editor couldn't help smiling at the tale from Jeana Hall, whose husband William took the opportunity of lockdown to overhaul parts of his garden line that includes a very impressive viaduct. But then the rains came "and in a moment of weakness I said he could work in the dining room." You can guess what happened next – Jeana returned from the shops to find track all over the dining room table and William replacing moss-covered sleepers. "There was muck everywhere and he was happy as a sandboy". And what did Jeana do? Made him a cup of tea – a match made in heaven...

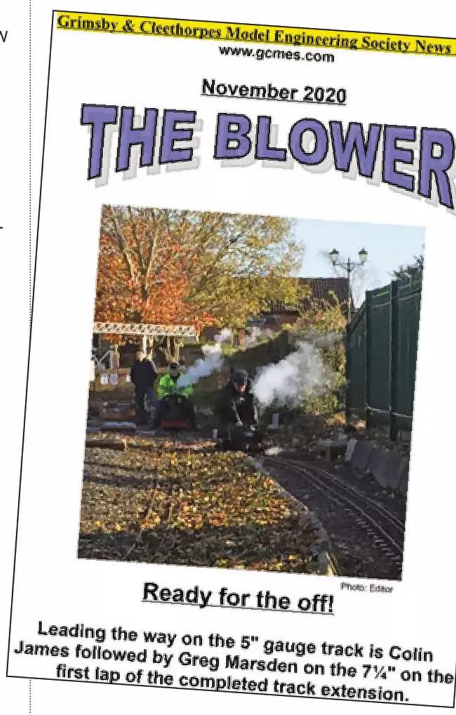
More good news leaps out of the cover of the latest edition of *The Blower*, newsletter of the Grimsby & Cleethorpes ME. Pictured are members Colin James and Greg Marsden, on 5-inch and 7¼-inch gauge locomotivess respectively, setting off on the first lap of the newly completed extension to the club's ground-level track.

"There was muck everywhere and he was happy as a sandboy..."

ABOVE: Now that's a stock yard. Superb aerial shot of GL5 action from 2017, with the man responsbile for the shot, Alan Whitehouse actually visible in the shot at bottom left.

RIGHT: The latest *Blower* from Grimsby has good reason to be in celebratory mood with the opening of the club's track extension.

The work was completed before lunchtime on 4th November, the club's final work day before another lockdown took effect, and "after a socially-distanced lunch" Colin and Greg wasted no time in steaming up their locos and trying the new line out. Pictures in *The Blower* show that ▶



TOP & ABOVE: Educational times at the St Albans club, with instructor Neil Byrne, in the red fleece, taking members Paul Watson and Michael Watts through the skills of handling a steam engine. *Photos: Mike Collins*

BELOW: Bristol president Bernard North is very happy with the club's newly acquired Romulus. *Photo: Richard Pearson*

the new extension, which includes a "fairly steep" descent from the station, is an impressive formation. Newsletter editor Neil Chamberlain also got in on the act, managing a couple of laps with his battery-powered class 31 and the club is now looking forward to an official opening ceremony hopefully some time in the Spring. Meantime if you put the society into Facebook's search feature you can watch video of members trying out the new track.

Other clubs also appear to be eyeing expansion of their facilities. The South Cheshire ME has been considering whether to follow the example of other clubs and install a 32mm/45mm gauge garden layout at its Nantwich site for the use of Gauge 1, 16mm and G Scale modellers. Sensibly the club is canvassing opinion from local clubs and groups in those scales – let's hope this project comes to fruition as many model engineers gain great satisfaction from working in the smaller scales.

Not such good news from Cassiobury Park, home of the 10¼-inch gauge Watford Miniature Railway – run by a private operator rather than a club but worthy of mention here. It seems the line planned to reopen in December after Covid restrictions but discovered that work by the local council to relay an adjacent path had resulted in damage to a level crossing, several weeks of repairs needed before reopening can be considered. Was the railway pre-warned of the path work? Of course not, and now management of the park has apparently upset so many of its users that the Local Government Ombudsman has been asked to launch a formal investigation...

Back to smiles of a domestic nature on opening the latest edition of the St Albans & District ME newsletter, with editor and club chairman Mike Collins immediately revealing on the front cover "I'm in the dog house at the moment for treading swarf around the house..."

Under instruction

A highlight of the St Albans issue is photo coverage of a driver training day at the club's Puffing Park track on 14th October, with two members being instructed on the club's Polly locomotive – the training included everything from getting the loco out of its container to the essential pre- and post-run inspections, as well as actually controlling it on the track. All essential behind-the-scenes stuff that many miniature railway visitors likely don't appreciate.

One interesting note from Mike reports that as the St Albans club rents its current site and is therefore at the mercy of future possible rent rises, initial studies are taking place with a view to finding an alternative site with more security of tenure. Mike adds, however, that "nothing will happen fast" and the club will remain at the Puffing Park for the foreseeable future.

All smiles too at the Bristol SMEE, a club that has faced its share of challenges in recent times. President Bernard North features on the cover of the latest newsletter, happily sitting astride a 7¼-inch gauge Romulus loco newly acquired for duties at the Ashton Court track. Purchased from a member, the loco is expected to be a worthy addition to the ground-level fleet operating at the popular track in 2021.

Like many other clubs all Bristol activities at Ashton Court were suspended from 5th November following the latest lockdown, but before that the club did manage to run a couple of public running days in the Autumn – these were highly successful with positive feedback from visitors. Ashton Gate also hosted the annual meeting of the Bulleid Builders Group on 7th September – as the picture on the next page shows members brought along some impressive projects.

Odd statements in club newsletters always catch the editor's eye so I felt obliged to read on when the Guildford ME chairman in a recent edition of *GMES News* claimed that Swedish fashionable furniture giant IKEA was a purveyor of model engineering supplies! Turns out he was making up a boiler test rig, combining a commercially available hand pump with polyurethane pipe and connectors. He needed something sturdy and waterproof on which to cut the pipe, and the solution was a nylon chopping board obtained for a whole £1 from.... IKEA Okay you nearly had us there...

Of course supermarkets should not immediately be ignored by the value-seeking model engineer – the likes of Lidl and Aldi are renowned for suddenly offering short runs of workshop supplies on their limited edition counters in the centre of the store, and while the items on offer are firmly at the value end of the range rather than the quality end, they can serve a purpose. Tech ed Harry relates in this issue how he has had plenty of use out of a set of step drills bought from Aldi for a whole £2.99...

Elsewhere in the Guildford newsletter the virtual 'bits & pieces' meetings started on Zoom during lockdown are continuing to be a success, more members who cannot travel to the clubhouse joining in and a very wide variety of subjects aired – from making a Gauge 1 dock tank and clack valves for a traction engine to repairing a bike stand. As we have said before these online meetings, increasingly being employed across the club scene, are excellent initiatives keeping many a member connected.

Yet more smiles, sympathetic ones this time in the pages of another 'Covid-19 chaos special issue' of *The Newsletter* from the **York ME**. Member Don Paton describes how he has been downsizing, principally going from 5-inch to O Gauge, due to approaching octogenarian status. Don adds, however that first his motorbikes had to go; "I had developed a habit of falling off the things, which was quite upsetting at the time, and hurt!"

Downsized delights

Don describes how his workshop has been downsized to make room for an O-gauge layout suspended from the ceiling. With the track almost complete he intends to get into both kit and scratchbuilding model locomotives, proving something else we constantly bang on about – you can still enjoy your model engineering, even if the traditional scales become too large to be practical – there's no less skill involved in home building a loco in say Gauge 1 or 16mm scale than in 3½-inch gauge...

Good to read in the pages of the highly frequent newsletter of the **Chingford & District ME** that the most recent public running days proved very successful. Even with the reduced capacity brought on by Covid-19 precautions the club has still carried around 1500 fare-paying passengers since reopening in August. The chairman reports that the revenue from these has helped the bank balance and ensured the future of the club next season and beyond, but once the bills are paid there won't be much left over to pay for very many winter projects. Unfortunately something most clubs will have to accept this particular winter we feel.

"I'm in the dog house at the moment for treading swarf around the house..."

ABOVE: Plenty of interesting metal to view when the Bulleid Builders Group held their annual meeting at the Bristol club recently. By the way the club tells us that the picture makes the members look closer than they were and social-distancing measures were observed to the full. *Photo courtesy Bristol SME:*

One lockdown advantage has been the appearance of even more useful articles in newsletters as club members commit to paper what they would normally impart in a meeting at the club. The York newsletter is a case in point with a useful discourse on the T-bar, used for clamping things down on milling tables and the like. Member Ted Joliffe describes the plusses and minuses of these humble but necessary items and how to construct effective examples – it's all very useful stuff...

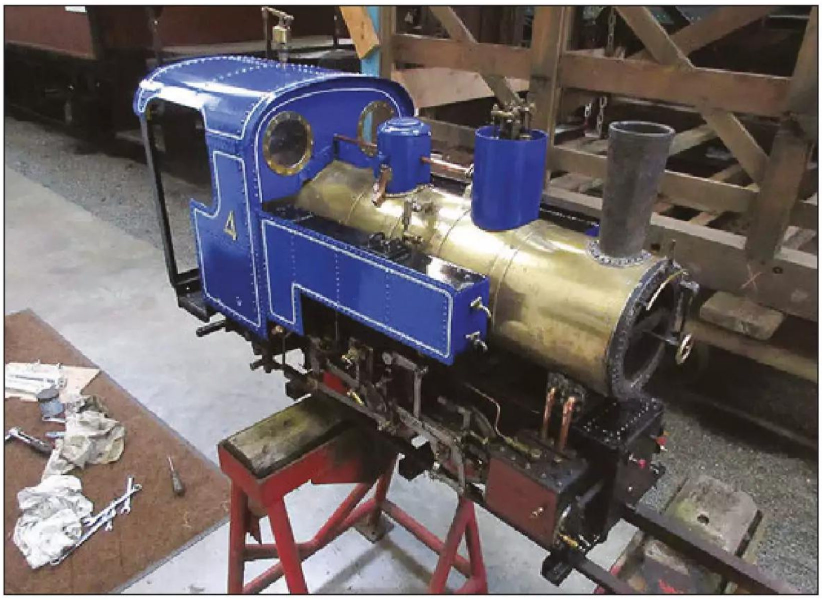
A brief mention of the **Ryedale SME** newsletter, the most recent edition of which includes a photo of a 5-inch gauge J63 locomotive that recently ran at the club's Gilling track. The loco has been deliberately weathered, a technique far more prevalent in the indoor model scales than in model engineering circles. Very realistic it looks too, but one can imagine such a treatment might attract its supporters and detractors...

French miniatures

Finally just room left this month to make a quick hop across the English Channel – the rather attractive 5-inch gauge Decauville illustrated at the bottom of this page has been restored and repainted by members of the **Museum of French Steam Tramways and Secondary Railways** (MTVS).

This group has been establishing a new steam centre and running line at Crèvecœur-le-Grand, halfway between Dieppe and Paris, after being forced to move from its previous home due to local difficulites, and is making good progress, regularly appearing in the news pages of our sister magazine *Narrow Gauge World*. The facilities at the new centre include a miniature railway on which the Decauville will be kept busy.

Of course France has endured Covid-induced lockdowns too and MTVS spokesman Oliver Janneau did report that one advantage of restoring the Decauville compared to the group's metre-gauge locos is that most work can be done at home! EIM



RIGHT: This delightful 5-inch Decauville will be hauling trains in France in 2021. *Photo: Olivier Janneau, MTVS*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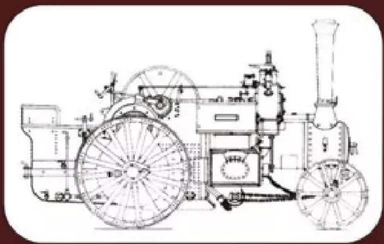

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